

BRIEF REPORT

The Effects of Shared Environment on Adult Intelligence: A Critical Review of Adoption, Twin, and MZA Studies

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There has been a vigorous debate for decades concerning the heritability of intelligence. In recent years, the debate has been focused on whether the components of IQ variability change with age and on separating environmental effects into shared and unshared components. Citing evidence from adoption studies, studies comparing identical and fraternal twins, and studies of identical twins raised apart, some prominent psychologists have concluded that the shared environment has a significant effect on the intelligence of children but little or no effect on the intelligence of adults. In this article, the evidence from such studies is reviewed. The article reaches the conclusion that while there is some evidence from adoption studies supporting the claim that shared environment has little or no effect on adult intelligence, that evidence is inconclusive and is inconsistent with evidence from twin studies and from studies of identical twins reared apart.

Keywords: twins, shared environments, intelligence, behavioral genetics

There has been a vigorous debate for decades concerning the heritability of intelligence—the degree to which variability in human intelligence can be explained by genetics, as opposed to the environment. In recent years, a focus of the debate has been on whether the components of IQ variability change with age and on separating environmental effects into shared and unshared components. The shared environment refers to all environmental factors that tend to make individuals raised in the same home similar to one another. This would include family characteristics such as socioeconomic status, child-rearing practices, cultural factors, and so on (Jensen, 1997, 1998).

Numbers of prominent scholars have concluded that the shared environment has a significant effect on the intelligence of children but little or no effect on the intelligence of adults. For example, Arthur Jensen wrote the following:

The shared environmental variance diminishes from about 35 percent of the total IQ variance in early childhood to near zero percent in late adolescence. The nonshared environmental variance remains nearly constant at around 20 to 30 percent from childhood to maturity. That is, virtually all of the nongenetic variance in adult IQs is attributable to *within-family* causes, while virtually none is attributable to the kinds of environmental variables that differ *between families*. (Jensen, 1998, p. 168, italics in original)

Similarly, Sandra Scarr (1997) wrote,

There is evidence in North American and Western European populations for quite high heritability of IQ past childhood (about 70%), with

small effects of differences between families, which would include most parental socialization differences. The unexpected finding is that most of the environmental variation is found in unique, individual experiences that siblings do not share (that is, environments that make siblings dissimilar). (pp. 27–28)

A similar view was expressed by Loehlin, Horn, and Willerman (1997): “The major contributor to familial resemblance [in intelligence] is the genes. Shared family environment has an appreciable effect on IQ when children are small, but this becomes minor by the time they are late adolescents (p. 123).”

The conclusion that shared environment has no effect on adult intelligence is based on three types of studies—studies in which two or more unrelated individuals are raised in the same home (adoption studies), studies comparing identical to fraternal twins (twin studies), and studies of identical twins reared apart (monozygotic twins reared apart [MZA] studies). The purpose of this article is to critically examine the evidence from each type of study.

Adoption Studies

The evidence most often cited in support of the claim that shared environment has little or no effect on adult intelligence comes from adoption studies. There have been nine such studies reported in the literature. Seven of them—Freeman, Holzinger, and Mitchell (1928); Burks (1928); Leahy (1935); Skodak and Skeels (1945, 1949); Scarr (1977); and Petrill et al. (2004)—involve IQ scores of participants who were mostly or entirely children or young adolescents who were 16 years old or younger. One (Scarr & Weinberg, 1978) involved participants who were mostly between 16 years and 22 years old, with an average age of 18 years. One (Teasdale & Owen, 1984) involved mostly participants who were 18 years old, and one (Loehlin et al., 1997) was a longitudinal

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study in which participants were given IQ tests once at a median age of 8 years and again 10 years later.

Table 1 gives the correlations for the studies involving mostly or only participants who were 16 years old or younger. Table 2 gives correlations for studies involving mostly or only participants who were between the ages of 16 and 22 years.

The average correlation between unrelated adopted siblings, weighted by sample size, for roughly 700 pairs of participants who were mostly or entirely 16 years or younger is .26. (The 95% confidence interval is .19 to .33.) The average correlation, again weighted by sample size, for about 300 pairs who were mostly or entirely between the ages of 16 and 22 years is minus .01, virtually zero. (The 95% confidence interval is 0 to .12.) These numbers provide evidence that shared environment has a significant effect on intelligence for children and early adolescents but not for participants once they have reached late adolescence.

Referring to these results, McGue, Bouchard, Iacono, and Lykken (1993, p. 66) wrote, "Adoption studies suggest that once adoptive siblings leave their shared rearing home they bear no resemblance in IQ." Other authors drew similar conclusions.

Discussion of Adoption Studies

The results of adoption studies do, without question, provide evidence in support of the claim that shared environment has little or no effect on human intelligence beyond childhood and early adolescence. Whether that evidence is conclusive or merely suggestive is debatable, for several reasons.

One such reason is that families who adopt children may not be representative of the general population. Adoptive parents are both self-selected and screened by agencies. They are, on average, significantly older, better educated, and wealthier than biological parents are. The decision to adopt indicates an unusually strong interest in rearing children. It is a decision that is made intentionally, usually after considerable reflection, whereas biological children are sometimes the result of unplanned pregnancies. People who, for one reason or another, are probably not in a good position to provide children with a suitable environment—including, for example, people with problems involving drugs or alcohol, with a history of psychological or behavioral problems, or with an inadequate income—will, in most cases, be screened out.

Another potential problem with adoption studies is that any inaccuracies in the age norming or gender norming of the tests could lead to inaccurate correlations. Several studies—including Freeman et al. (1928), Skodak and Skeels (1949), and Scarr and Weinberg (1978)—reported such problems.

Table 1

IQ Correlations of Unrelated Pairs of Siblings Raised in the Same Home for Studies of Children

Study	<i>r</i>	<i>n</i>
Skodak & Skeels (1949)	.50	63
Freeman et al. (1928)	.36	112
Scarr (1977)	.33	187
Texas Phase I: Loehlin et al. (1997)	.16	181
Burks (1928)	.11	28
Colorado: Plomin & DeFries (1983)	.09	90
Leahy (1935)	.08	35

Table 2

IQ Correlations of Unrelated Pairs of Siblings Raised in the Same Home for Studies of Late Adolescents

Study	<i>r</i>	<i>n</i>
Teasdale & Owen (1984)	.02	24
Texas Phase II: Loehlin et al. (1997)	-.01	181
Scarr & Weinberg (1978)	-.03	84

Another potential problem was the variety of differences in what types of participants were included in the different studies and in how the different studies were designed. Most of the studies were restricted to children who were placed in adoptive homes very early in life, prior to the age of 1 year. The Freeman study (Freeman et al., 1928) included many who were placed much later, including several who were placed as teenagers. Also, most studies involved children who were born mostly or entirely to unmarried mothers. Only about a third of those in the Freeman study (Freeman et al., 1928) were born to mothers who were not married. Also, most studies involved children born mostly or entirely to White parents. (The Burks, 1928; Leahy, 1935; and Skodak & Skeels, 1945, 1949, studies were further restricted to exclude children whose biological parents were not of Northern or Western European ancestry. The Burks, 1928, and Leahy, 1935, studies were restricted still further to exclude children whose biological parents were Jewish.) The Freeman et al. (1928) study included some Blacks, and the Scarr (1977) study looked primarily at Black children who were adopted by White families. Each of these differences could have significant consequences for the results of the study.

It is worth noting that correlations from adoption studies for children vary over a wide range, going from .08 and .09 for the Leahy (1935) and Colorado (Plomin & DeFries, 1983) studies to .50 for the Skodak and Skeels (1949) study. The correlations cluster into two groups—four correlations are between .08 and .16, and three are between .33 and .50. It is potentially misleading to summarize such disparate correlations in a single average rather than to try to explain what accounts for the differences.

It is also worth noting that the standard deviations in adoption studies vary over a wide range, going from 9.0 in one of the Scarr studies (Scarr & Weinberg, 1978) to 15.9 in the Freeman et al. (1928) study. Standard deviations are given in Table 3 for the studies of children and in Table 4 for the studies of adolescents. Studies with standard deviations substantially below 15 involved

Table 3

Standard Deviations for IQ Scores From Studies of Adopted Children

Study	<i>SD</i>	<i>n</i>
Freeman et al. (1928)	15.9	401
Skodak & Skeels (1949)	15.5	100
Burks (1928)	15	214
Scarr (1977)	12.6	67
Leahy (1935)	12.4	194
Texas Phase I: Loehlin et al. (1997)	11.5	256
Colorado: Plomin & DeFries (1983)	10.7	194

Table 4
Standard Deviations for IQ Scores From Studies of
Adopted Adolescents

Study	SD	n
Texas Phase II: Loehlin et al. (1997)	13.6	256
Scarr & Weinberg (1978)	9.0	150

Note. Teasdale and Owen's (1984) study was not included in this table because it did not include information on the standard deviation.

participants who were not representative of the general population in terms of genetic or environmental variability or both. It would seem questionable to use these studies to estimate components of variance, including variance due to the shared environment, for the general population.

Twin Studies

By comparing the IQ correlations of monozygotic (MZ) twins raised in the same home with dizygotic (DZ) twins raised in the same home, making certain assumptions, one can estimate the proportions of variability in intelligence due to genetics, the shared environment, and the unshared environment.

McGue et al. (1993) reviewed MZ and DZ correlations from published twin studies for five age groups—4 to 6 years, 6 to 12 years, 12 to 16 years, 16 to 20 years, and adult. Using the weighted average correlations for each group, McGue et al. (1993) reported that the estimated proportion of IQ variability that is explained by the shared environment “is relatively constant at approximately 30% for ages up to 20 years but then drops to 0% in adulthood” (McGue et al., 1993, p. 64). They and other authors interpreted these numbers as being supportive of the results from adoption studies.

Similar results were obtained by Haworth et al. (2010) in a study of 11,000 pairs of twins from four countries. Among children (age range 4–10 years, average age 9 years), 33% of IQ variability was due to the shared environment, compared with 26% that was due to the unshared environment. This decreased dramatically for adolescents (age range 11–13 years, average age 12 years), for whom 18% of IQ variability was due to the shared environment, and 27% was due to the unshared environment. It then decreased slightly for young adults (age range 14–34 years, average age 17 years), for whom 16% of IQ variability was due to the shared environment, and 19% was due to the unshared environment.

Discussion of Twin Studies

Actually, the evidence from twin studies *does not support* the evidence from adoption studies; it *contradicts* it. As we have seen, the three adoption studies involving participants beyond childhood are studies primarily involving late adolescents. (The average age of adoptees in the second phase of Loehlin et al.'s, 1997, Texas study is 18 years. The average age of participants in Scarr & Weinberg's, 1978, study is 18½ years. Participants in Teasdale & Owen's, 1984, study are Danish men reporting to their draft board at the age of 18 years or shortly thereafter. There has never been an adoption study primarily involving adults over the age of 20 years.)

Thus, the appropriate comparison is not between the adoption studies and the studies of adult twins. It is between the adoption studies and the studies of twins between the ages of 16 years and 20 years.

For twins in that age group, the estimated proportion of variability due to the shared environment is around 30%. This contradicts the results of the adoption studies for participants in that age range, which indicate little or no effect for the shared environment. The only way to interpret the evidence from adoption and twin studies as being mutually supportive is to be careless about the definition of the word *adult*.

It is worth noting that the twin studies involve far larger sample sizes than do the adoption studies. The twin studies include more than 2,600 pairs of participants (McGue et al., 1993) versus less than 300 in the adoption studies.

What about twin studies of adults over the age of 20 years? There have been five published studies involving the intelligence of twins, most or all of whom were over 20 years (McGue et al., 1993; Pedersen, Plomin, Nesselroade, & McClearn, 1992; Shields, 1962; Tambs, Sundet, & Magnus, 1984; and Vernon, 1989). Correlations for each of these studies are given in Table 5.

The weighted average for all MZ pairs is .841, while the weighted average for all DZ pairs is .392. These numbers give estimates of 90% for the proportion of IQ variability explained by genetics, 16% for the proportion explained by the unshared environment, and minus 6% for the proportion explained by the shared environment, but a negative proportion is impossible. What should one do when one gets an impossible estimate?

What McGue et al. (1993) did was increase the negative estimate for the unshared environment from minus 6% to zero. They then decreased the estimate for genetics by the same amount, so that the components still add to 100%. This led to estimates of 84% for genetics, 0% for the shared environment, and 16% for the unshared environment, but they could just as easily have decreased the estimate for the unshared environment instead of the estimate for genetics. That would give estimates of 90% for genetics, 0% for the shared environment, and 10% for the unshared environment. They do not explain why they make the first adjustment rather than the second.

Another point to consider is that the ages of participants in these studies range all the way from the early 20s to the late 80s, but if one is considering whether the components of IQ variation change with age, there is no reason to assume a priori that any changes

Table 5
IQ Correlations for Pairs of MZ and DZ Adult Twins

Study	MZ pairs		DZ pairs	
	r	n	r	n
Shields (1962)	.76	34	.703	3
Tambs et al. (1984)	.885	40	.474	40
Vernon (1989)	.935	50	.526	32
Pedersen et al. (1992)	.80	63	.22	79
McGue et al. (1993), Group I	.80	51	.52	35
McGue et al. (1993), Group II	.85	91	.40	68

Note. For McGue et al. (1993), Group I refers to participants between the ages of 30 years and 59 years, and Group II refers to participants between the ages of 60 years and 88 years. MZ = monozygotic; DZ = dizygotic.

stop at age 20 years. There may be differences between young adults, the middle aged, and the elderly.

If one looks separately at adults under 60 years and those over 60 years, one gets very different results for the two groups. For those under 60, the estimates are 68% for genetic variation, 17% for the shared environment, and 15% for the unshared environment. For those over 60 years, the estimates are 105% for genetics (an impossible number), minus 22% (also an impossible number) for the shared environment, and 17% for the unshared environment.

Thus, there are at least two major problems with McGue et al.'s (1993) conclusion that studies of adult twins indicate little or no effect of the shared environment on adult intelligence. One problem is that they made a questionable statistical adjustment in order to deal with a negative estimate of a quantity that cannot be negative. The other problem is that their conclusion requires grouping together adults of all ages, but if young and middle-aged adults are treated as a separate group from the elderly, the results look very different. For young and middle-aged adults, the estimated effects of the shared environment are slightly *greater* than are those of the unshared environment. For the elderly, the estimated effects of the shared environment are negative, a result that is impossible.

MZA Studies

Studies of identical twins reared apart do not provide an estimate of variation due to the shared environment. They do, however, provide an estimate of genetic variation. There have been five such studies that have been published (Bouchard, Lykken, McGue, Segal, & Tellegen, 1990; Juel-Nielsen, 1965; Newman, Freeman, & Holzinger, 1937; Pedersen et al., 1992; and Shields, 1962). Correlations for the studies range from .64 to .78, with a weighted average of .73. This weighted average, under certain assumptions, can be used as an estimate of genetic variation.

Because most MZA participants are adults and because studies of children result in a substantially smaller estimate of genetic variation than .73, this result has been interpreted as supporting the hypothesis that shared environment is less important and genetics are more important for adults than for children.

Discussion of MZA Studies

Use of the correlation for MZ twins reared apart as an estimate of the genetic component of IQ variation means assuming that the twins were separated shortly after birth and were raised in uncorrelated environments, but it has been pointed out many times that these assumption are not even close to being true for many pairs in the Newman et al. (1937), Shields (1962), and Juel-Nielsen (1965) studies, which include short biographies of all participants. Many of the pairs were not separated until years after birth, were reunited while still children, or were brought up in very similar environments, often by different members of the same family. (The other two studies do not include biographies, so the assumptions cannot be checked.)

In the Shields (1962) study, for example, six of the 38 pairs of twins were not separated until they were between 4 and 9 years old, and eight pairs were reunited by the age of 12 years, including

two pairs who were reunited at the age of 8 years. For almost half the pairs, the twins were brought up by different first-degree relatives—one by the mother and the other by the maternal grandmother, one by the mother and the other by a maternal aunt or uncle, one by the father and the other by a paternal aunt or uncle, or each by two different paternal aunts. Among the pairs of “reared-apart” twins in the study were

- a pair (Edward and Keith) who were brought up in the same orphanage but were counted as being separated because they lived in different cottages located a mile or two apart;
- a pair (Bertram and Christopher) who grew up next door to each other, were raised by different paternal aunts, and were “constantly in and out of each others’ houses” (Shields, 1962, p. 164); and
- a pair (Odette and Fanny) who spent half the year with their mother and the other half with their maternal grandmother, but at alternating times. For 6 months, Odette would stay with the mother and Fanny with the grandmother. Then, they would switch, with Odette going to the grandmother and Fanny going to the mother.

Another way to analyze the MZA studies is to look at IQ scores of adult pairs in which one of the twins grew up in a clearly more favorable family environment than the other. This raises obvious problems of subjectivity, since people will inevitably disagree about how children should be raised, what the most important elements of the environment to consider are, and so on. Nevertheless, in the more extreme cases—pairs in which one twin was raised in a stable, loving home and the other was not or pairs in which one twin had far better educational opportunities—there would be little, if any, debate.

Consider, for example, the following five pairs. (The first three are from the Newman et al., 1937, study; the fourth is from the Juel-Nielsen, 1965, study; and the last is from the Shields, 1962, study. The members of each pair are listed alphabetically.)

- Gladys and Helen: Gladys was raised in a home in which she was needed to do housework, and she completed only the second grade. Helen was raised in a home in which education was encouraged. She completed high school and college, and she became a teacher.
- Thelma and Zelma: Thelma completed high school and attended normal school for part of a year, becoming trained as a teacher. She taught school for 1 year. Zelma, who wanted to become a nurse, was forced to leave school just prior to entering high school because her mother was in ill health.
- James and Reece: James was raised by his maternal grandparents, who were “people of steady and industrious character.” He completed high school. Reese was raised by his paternal grandparents, people “of a type common in the mountains of Tennessee. They are regular mountaineers of the more primitive sort.” The paternal grandfather never held a steady job. Reece “attended a mountain school when he felt so inclined, but never for more than 5 months in the year,

usually much less. He continued . . . through the eighth grade" (Newman et al., 1937, p. 306).

- Ingrid and Olga: Ingrid lived in a foster home in which the foster parents were "well-situated, deeply religious farmers." Olga lived until the age of 7 years in a foster home that was "a rather poor and disharmonious labourer's home." Because of problems in the home, at age 7 years, she left it and, thereafter, lived in an orphanage (Juel-Nielsen, 1965, p. 65).

- Berta and Herta: The twins were born in South America to Scandinavian parents. Berta, at the age of 4 years, was sold by her father in order to settle debts incurred in an effort to salvage sunken treasure. (He also attempted unsuccessfully to sell Herta.) She was raised in South America by "a successful, go-ahead medical practitioner." She went to high school until the age of 16 years, "then studied social science, languages, and the piano" until she got married at the age of 22 years. Herta "lived with her parents at various places in South America, mostly lonely parts of the coast where she had no schooling, until at the age of 9 she moved with her mother to rural Scandinavia, where the father later joined them." The parents eventually divorced. The father was hospitalized for mental illness a number of times, and he "made dramatic attempts at suicide by swallowing broken glass, razor blades, and a bottle of furniture polish." She left school at the age of 14 years to become a nursemaid (Shields, 1962, pp. 221–222).

It is difficult to imagine anyone disagreeing that Helen, Thelma, James, Ingrid, and Berta were all raised in clearly more favorable family environments than were their twins. IQ scores of all 10 participants are given in Table 6. In each case, the twin from the more favorable environment had a higher IQ, and in three cases, by at least 19 points. The average difference was 16 points (The 95 percent confidence interval is 5 to 27 points).

This would, of course, not mean anything if there were an equal number of other twin pairs in which the participant from the clearly more favorable home had the *lower* IQ. However, having looked through the biographies of all twin pairs from the three studies that included biographies, I do not believe there is even a single pair in which that is the case.

The Role of Assumptions

The validity of conclusions drawn from adoption, twin, and MZA studies depends on whether the assumptions underlying

these studies are at least approximately satisfied. Among the most important of these assumptions are that families with adopted children are representative of the general population; that fraternal twins share their environments to the same degree as do identical twins, at least for those aspects of the environment that impact intelligence; that identical twins raised apart were separated at birth or shortly thereafter and had little contact later in life; that the intrauterine environment has little or no effect on IQ; and that the twins were brought up in uncorrelated environments. Also of concern is whether statistical problems involving the scoring of IQ tests, such as inaccurate age and gender norming, bias the results. To the degree that any of these assumptions are not satisfied, results of the studies are inconclusive.

In my opinion, far too little attention has been paid to whether the assumptions underlying these studies are flawed to an extent that seriously undermines the validity of the results. There have been a modest number of articles and books that have addressed the validity of these assumptions. (For twin studies, these include Bouchard, 1993, 1997; Bouchard & Loehlin, 2001; Joseph, 2004; Loehlin & Nichols, 1976; Rowe, 1994; and Segal, 1999. For MZA studies, they include Bouchard, 1982; Farber, 1981; Kamin, 1974; and Shields, 1978. For adoption studies, they include Loehlin & Horn, 2000; McGue et al., 2007; and Stoolmiller, 1998, 1999. See also Kaplan, 2001; Kempthorne, 1978; and Plomin, DeFries, McClearn, & Rutter, 1997.) However, despite occasional claims made to the contrary (Sulloway, 2007, for example), this is a complicated matter that is not close to being settled. Nevertheless, most of the time, little or no attention is paid to the problem.

Conclusion

Quantitatively estimating components of variability in IQ scores is a complex and controversial topics that has been widely discussed for nearly a century. A relatively recent development is that many behavior geneticists have reached the conclusion that the shared environment has little or no effect on the IQ scores of adults, although it does have a substantial effect on the scores of children. This conclusion is based on the results of three types of studies—adoption studies, twin studies, and studies of identical twins raised apart (MZA studies).

In this article, I point out three aspects of the evidence that have been overlooked. The first point is that adoption and twin studies are inconsistent, despite what has often been claimed. The argument that the two types of studies are consistent has come from comparing adoption studies of *adolescents* with twin studies of *adults* over 20-years old. Adoption studies of adolescents lead to very different results than do twin studies of adolescents, and that is the appropriate comparison. (There are no published adoption studies of adults over 20-years old, so no comparison is possible with twin studies of adults over 20-years old.)

A second point is that twin studies of young and middle-aged adults lead to very different results than do twin studies of the elderly. Previous studies have combined adults of all ages, leading to possibly misleading conclusions.

The final point involves studies of identical twins reared apart in which biographical information is given for each of the participants. In a handful of pairs, one twin was raised in an environment

Table 6
IQ Scores for Selected MZA Pairs

Pair	Twin 1	Twin 2	Difference
Helen & Gladys	116	92	24
Thelma & Zelma	116	109	7
James & Reece	96	77	19
Ingrid & Olga	104.5	99	5.5
Berta & Herta	56	32	24

Note. The mean score for the IQ test given to Berta/Herta is 66 rather than the conventional 100. MZA = monozygotic twins reared apart.

that was clearly more favorable for intellectual development than was the other twin. In each of those pairs, the twin from the more favorable environment had the higher IQ score. Previous studies have looked at only the overall correlations and have not analyzed individual pairs.

If these points are taken into consideration, the evidence concerning the effects of the shared environment on adult IQ becomes mixed and inconclusive. The results of adoption studies tend to show that there is little or no effect, but the results of twin and MZA studies tend to show that there is a substantial effect.

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