Research Article

INDIVIDUAL DIFFERENCES IN TELEVISION VIEWING IN EARLY CHILDHOOD: Nature as Well as Nurture

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Abstract—*Although there has been a tremendous outpouring of research on the consequences of children's television viewing, little is known about the causes of individual differences in television viewing, which is one of the major activities of childhood. We present results from the first parent–offspring and sibling adoption analyses of individual differences in time spent watching television in early childhood, and we consider IQ and temperament as possible mechanisms of genetic influence. The sample consisted of over 220 adopted children studied at 3, 4, and 5 years of age, the complete sample of probands from the Colorado Adoption Project. Also assessed are the adoptees' biological and adoptive parents, matched nonadoptive families, and younger adoptive and nonadoptive siblings. Both the parent–offspring and sibling adoption designs yielded evidence for significant genetic influence on individual differences in children's television viewing. Neither IQ nor temperament appear to be responsible for this genetic influence.*

Television viewing is one of the major activities of childhood. During early childhood, U.S. children watch television over 2 hours per day (Liebert & Sprafkin, 1988). However, the range of individual differences in television viewing is almost as remarkable as the total amount of television viewed (Tangney & Feshbach, 1988). For example, in one study (Lyle & Hoffman, 1972), more than one third of first graders watched 4 or more hours on a typical school day whereas one tenth reported not watching at all. Standard deviations for hours per week of television viewing are often about 10 hours during childhood (e.g., Institute for Social Research, 1981). Moreover, individual differences in television viewing are highly stable during childhood (Huston et al., 1990).

Why do some children watch so much more television than others? Despite thousands of studies on the consequences of television viewing—2,500 research publications between 1972 and 1982 (Pearl, Bouthilet, & Lazar, 1982)—next to nothing is known about the origins of these individual differences (Bryant, 1990). One might expect that parents determine how much television their children are permitted to watch, especially early in childhood. To the contrary, surveys indicate that most parents do not restrict their children's television viewing; for example, in one study, 70% of parents put no restrictions on the amount of time their first graders watched television (Lyle & Hoffman, 1972). Although parents do not generally control television viewing of young children, it is possible that they play an indirect role in modeling, encouraging, and facilitating television viewing. This hypothesis implies that individual differences in children's viewing are due in part to their parents' behavior, including perhaps the parents' own television viewing. To the extent that the family environment governs television viewing, we would expect siblings to be similar in time spent watching television. One study of high-school siblings indicated that siblings do in fact resemble each other in time spent viewing violent television programs (Rowe & Herstand, 1986). To our knowledge, no data have been reported concerning the resemblance between parents and children for television viewing.

Although it seems most reasonable to predict that the major source of individual differences in young children's television viewing is the family environment, it is also possible that genetic differences among children play a role. Of course, there can be no genes for television viewing just as there are no genes for performance on IQ tests or for height. Complex phenotypes such as these are heritable but not inherited. That is, we do not inherit genes that code for vocabulary words or for height, and we cannot inherit genes that code for television viewing. Genes only code for sequences of amino acids; genetic differences among individuals in the coding of these polypeptides can produce heritable effects on a particular phenotype indirectly (pleiotropically), including complex phenotypes such as performance on IQ tests or height or television viewing. In other words, finding genetic influence on individual differences in children's television viewing means that some unspecified genetic differences among children indirectly affect the extent to which children watch television. It would seem to be a reasonable first step towards understanding the origins of individual differences in television viewing to investigate the extent to which genetic factors are involved. If genetic effects are found, a next step is to consider possible mechanisms of genetic influence.

We are aware of only one behavioral genetic study that included any measures related to television viewing. In a study of

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high-school twins, a questionnaire of over a thousand items included one item that assessed total number of hours of television viewing per week (Loehlin & Nichols, 1976). The correlation for identical twins (r = .49) was slightly, but significantly, greater than the correlation for fraternal twins (r = .38), suggesting the possibility of genetic influence. Thus, the only behavioral genetic data relevant to television viewing suggest that differences among children in their television viewing time may be influenced by genetic factors. This finding clearly warrants replication. Moreover, other designs are needed because twins, being the same age, might provide special mutual influences on the time they spend watching television. Finally, results in adolescence might differ from those found in early childhood when television viewing habits are being formed.

The purpose of this paper is to present analyses from the Colorado Adoption Project (CAP; Plomin, DeFries, & Fulker, 1988) that explore the etiology of individual differences in television viewing in early childhood. The CAP includes information on television viewing of "genetic" (biological) parents and their adopted-away children at 3, 4, and 5 years of age, "environmental" (adoptive) parents who adopted these children, and "genetic-plus-environmental" (nonadoptive) parents and their children in families matched to the adoptive families. In addition, younger adoptive siblings of the adopted children and younger siblings of the nonadopted children were studied at 3, 4, and 5 years of age to provide information on "environmental" (adoptive) and "genetic-plus-environmental" (nonadoptive) sibling relationships, respectively. If heredity affects television viewing, biological parents' television viewing should predict television viewing of their adopted-away offspring. Also, resemblance in television viewing for nonadoptive parents and their offspring should exceed resemblance for adoptive parents and their adopted children. Finally, correlations for nonadoptive siblings should exceed correlations for adoptive siblings. If heredity is found to influence individual differences in children's television viewing, the contribution of other genetically influenced characteristics such as IQ and temperament can be investigated.

METHOD

Sample

The Colorado Adoption Project (CAP) is a longitudinal, prospective adoption study. The CAP sample is described in detail elsewhere (Plomin & DeFries, 1985; Plomin, DeFries, & Fulker, 1988). The present analyses include the entire CAP sample of children tested at 3, 4, and 5 years, consisting of 226 adoptive families and 233 nonadoptive families (see Table 1). These families include 82 adoptive sibling pairs and 95 nonadoptive sibling pairs at 3 years. The sample sizes for sibling and parent–offspring comparisons are listed in Tables 2 and 3. Nearly 90% of the biological parents and over 95% of the adoptive and nonadoptive parents report that they are Caucasian; the rest are primarily Hispanic and Oriental. Fifty-four percent of the children are female.

Selection of the CAP sample and its representativeness are discussed in the above references. In summary, the adopted children were separated from their biological mothers at the average age of 4 days and were placed in their adoptive homes at the average age of 28 days. Nonadoptive families were matched to the adoptive families on several criteria. In terms of occupational status, the adoptive and nonadoptive families are somewhat above the national average for the U.S. white labor force, although the CAP sample is nearly representative in terms of variance. Selective placement, matching of adoptive and biological parents, is negligible.

Table 1. *Means and standard deviations for hours of television viewing per week from 3 to 5 years in the Colorado Adoption Project*

	Adopted			Nonadopted		
Age	N	Mean	*SD*	N	Mean	*SD*
3	226	14.1	8.4	231	14.5	8.7
4	220	15.0	8.1	233	15.0	8.2
5	220	15.2	8.4	226	16.0	8.8

Procedures and Measures

Parents were administered a 3-hour battery of tests in small group-testing situations and were paid an honorarium for their participation. On average, biological parents were tested during the mothers' last trimester of pregnancy, and adoptive and nonadoptive parents were tested when their children were 7 months old. Adopted and nonadopted children and their younger siblings were assessed during a home visit near each child's third and fourth birthdays (3.01 years, SD = .03; 4.01 years, SD = .04) and during a telephone interview at 5 years of age.

One of the questions asked of each of the parents was the following: "About how many hours a week do you usually watch television? (circle one) never watch, 1–5 hours, 5–10 hours, 10–20 hours, over 20 hours." Their responses were coded as 1, 2, 3, 4, and 5, respectively. At each age, television viewing of the children was assessed by means of a 10-minute interview conducted with their mothers. Mothers were interviewed concerning the number of times per week that the child watches the major children's programs, the number of hours spent watching Saturday and Sunday children's programs, and the number of hours per week that the child watches evening

Table 2. *Adoptive and nonadoptive sibling correlations and model-fitting estimates*

	Adoptive		Nonadoptive		Model-Fitting Estimates	
Age	r	N	r	N	$h^2 \pm$ SE	$c^2 \pm$ SE
3	.18	82	.45*	95	.54 ± .27	.18 ± .11
4	.26*	70	.57*	86	.62 ± .27	.26 ± .11
5	.34*	62	.43*	70	.19 ± .30	.34 ± .11

* $p < .05$

Table 3. *Parent–offspring correlations for biological, adoptive, and nonadoptive parents*

	Biological		Adoptive		Nonadoptive	
Age	Mother	Father	Mother	Father	Mother	Father
3	−.01	.18	.07	.09	.30*	.23*
4	.15*	.25*	.12*	.21*	.31*	.19*
5	.15*	.12	.16*	.11	.32*	.11*
Number of pairs	216–221	43–46	217–223	212–218	221–228	224–231

* $p < .05$

programs. These categories of television viewing time were summed to produce total television viewing hours per week.

In order to explore possible mediators of genetic influence on television viewing, IQ and temperament data from the CAP were employed. An abbreviated version of the Stanford-Binet Intelligence Scale was administered to the CAP children at 3 and 4 years. Temperament was assessed by parental ratings using the Colorado Childhood Temperament Inventory (Rowe & Plomin, 1977) that assesses the major genetically influenced temperament dimensions of emotionality, activity, sociability, and impulsivity (EASI) (Buss & Plomin, 1984).

Analyses

If features of the family environment affect television viewing, correlations for adoptive as well as nonadoptive siblings should be significant. If heredity is important, correlations for nonadoptive siblings should be greater than correlations for adoptive siblings. If parental television viewing relates environmentally to children's viewing, parent–offspring resemblance will be found in adoptive families as well as nonadoptive families. If heredity is involved in this association, parent–offspring resemblance will be greater in nonadoptive than adoptive families and adopted-away offspring will resemble their biological parents. (See Plomin, DeFries, & McClearn, 1990, for details.)

For these reasons, simple sibling and parent–offspring correlations are sufficient to provide a general understanding of the results, especially when assortative mating and selective placement are considered. Therefore, sibling and parent–offspring correlations are emphasized in the presentation of these results. However, a more comprehensive model-fitting approach that incorporates assortative mating and selective placement, analyzes all of the data simultaneously, and provides maximum-likelihood estimates of genetic and environmental parameters and their standard errors, will also be employed.

CAP sibling model.

The CAP sibling model is represented as a path diagram in Figure 1. It shows that the expected correlation between siblings' television viewing (P_1 and P_2) can be expressed as $h^2r_G + c^2$. From genetic theory, $r_G = .5$ for full siblings when mating is at random and genetic effects are additive; r_G is zero for adoptive sibling pairs when selective placement is zero. The h^2 and c^2 term are the proportions of the phenotypic variance in television viewing due to variation in additive genetic values and environmental influences shared by siblings, respectively. Nonshared environmental influences, shown as E_{w1} and E_{w2}, are uncorrelated and do not contribute to sibling resemblance. Thus, the phenotypic correlations (r_P) of nonadoptive and adoptive sibling pairs are functions of genetic and environmental influence as follows:

$$\text{nonadoptive } r_P = .5h^2 + c^2$$
$$\text{adoptive } r_P = c^2$$

In other words, doubling the difference between nonadoptive and adoptive sibling correlations estimates heritability (h^2) and the adoptive sibling correlation directly estimates the total impact of environmental influences shared by siblings in the same family. The size of the current CAP sibling sample permits little power to detect genetic influence because, in essence, the estimate of heritability depends on the difference between two correlations. However, the design is reasonably powerful in detecting the influence of shared environment—for example, if shared environmental influence accounts for 30% of the variance, the CAP sample at 3 years provides over 80% power to detect it.

CAP parent–offspring model.

A CAP parent–offspring model, modified from Jencks' (1972) elaboration of Wright's (1931) original work, has been

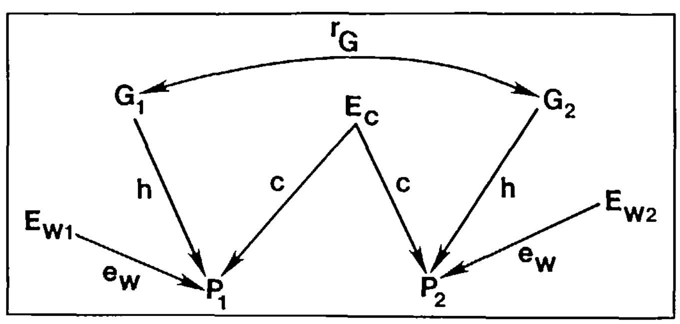

Fig. 1. Path diagram of the resemblance between siblings, where r_G is the additive genetic correlation; E_c is that part of the environmental deviation that is shared by siblings; and E_{w1} and E_{w2} are sources of environmental influence not shared by siblings. (From Plomin, DeFries, & Fulker, 1988)

presented elsewhere (Fulker & DeFries, 1983; Fulker, DeFries, & Plomin, 1988). A complete description of the path diagrams of genetic and environmental transmission in nonadoptive and adoptive families, and the corresponding expectations of variance and covariance matrices, can be found in Fulker and DeFries (1983). An introduction to model-fitting that leads to the CAP parent–offspring and sibling models and expectations of variances and covariances is also available (Plomin, DeFries, & Fulker, 1988).

Figure 2 shows path diagrams representing the CAP parent-offspring model that include only two latent variables, additive genetic value *G* and environmental deviation *E*, in both parental and offspring generations, and these totally determine the phenotype *P* with paths, *h* and *e*, respectively. The model incorporates assortative mating (*p* and *q*), selective placement (x_1 – x_4), and passive genotype–environment correlation (*s*) for nonadoptive and adoptive families. The three phenotypic variables in Figure 2a yield 3 expected correlations, and the five phenotypic variables in Figure 2b yield 10 phenotypic correlations for which expectations have been derived (Fulker & DeFries, 1983). The model was fit to variances and covariances calculated separately for adoptive and nonadoptive families. Expected covariances and variances based on the model were fitted to the observed covariance matrices using a maximum-likelihood estimation procedure similar to LISREL analysis of structural equation models (Jöreskog & Sörbom, 1984); the MINUIT package of optimization and error analysis routines, made available by CERN (1977), was employed. Eleven free parameters (including two variances) were estimated; two parameters (e and f) were computed as described by Fulker and DeFries (1983) because they are functions of the estimated parameters.

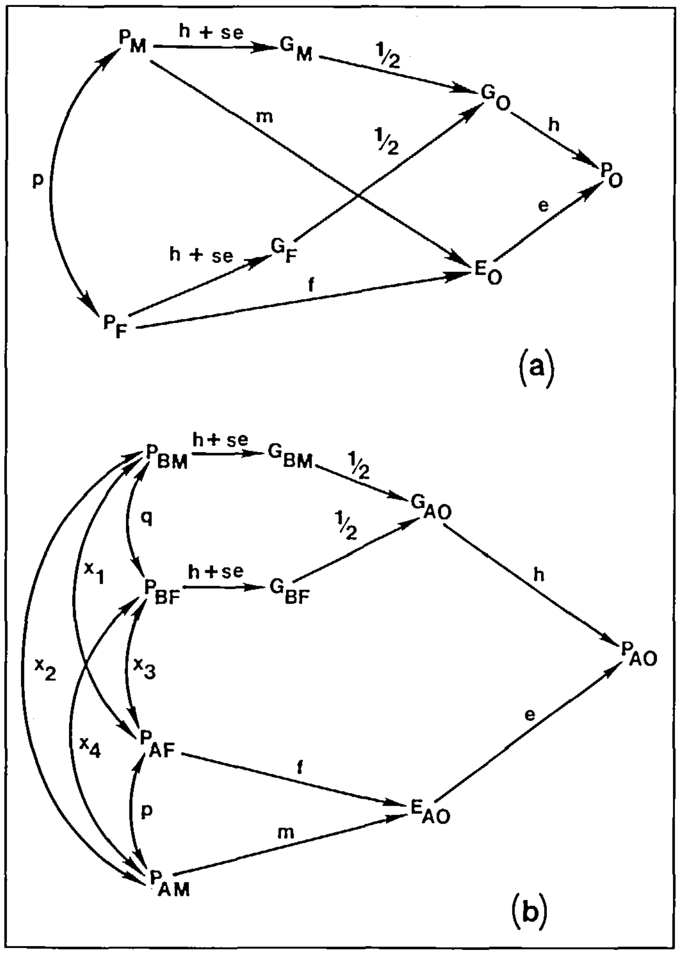

Fig. 2. Path diagrams of genetic and environmental transmission in nonadoptive (*a*) and adoptive (*b*) families. The model includes causal environmental transmission from phenotypes of mother (*m*) and father (*f*), assortative mating in nonadoptive and adoptive couples (*p*) and in biological couples (*q*), passive genotype–environment correlation (*s*), and selective placement (*x*). (From Plomin, DeFries, & Fulker, 1988)

RESULTS

Descriptive Statistics

Table 1 presents descriptive statistics for television viewing for CAP children from 3 to 5 years. CAP children watch approximately 2 hours of television per day on average, with an increase of about 1 hour per week from 3 to 5 years. CAP television viewing is slightly less than the U.S. average of about 2.5 hours per day at these ages (Liebert & Sprafkin, 1988). There are no significant mean or variance differences between adopted and nonadopted children. In addition, there are no significant variance differences between boys and girls, nor is there a significant mean gender difference at 3 years of age. At 4 and 5, girls watched significantly more television than boys.

The standard deviations indicate substantial variability among children. In the CAP sample at 3, the bottom tenth of the distribution watched less than 5 hours of television per week and the top tenth watched more than 25 hours per week. Longitudinal correlations indicate that rank orders of individual differences in television viewing are maintained to some extent during early childhood. The longitudinal correlations are .58 from 3 to 4, .54 from 4 to 5, and .49 from 3 to 5, slightly lower than those recently reported by Huston et al. (1990).

Parental television viewing also showed substantial variability, and no significant differences in variance were observed for biological, adoptive, and nonadoptive parents. On average, parents report that they watch from 5–10 hours of television per week. Biological parents reported watching less television than adoptive and nonadoptive parents. Means (and standard deviations) on the 5-point scale are 2.7 (1.1) for biological mothers, 2.6 (1.2) for biological fathers, 3.3 (1.0) for adoptive mothers, 3.1 (1.0) for adoptive fathers, 3.5 (1.1) for nonadoptive mothers, and 3.3 (1.0) for nonadoptive fathers.

Sibling Correlations

Sibling correlations for television viewing are presented in Table 2. Correlations are calculated from scores when each sibling was 3, 4, and 5 years. Significant environmental influence shared by siblings is implicated for television by the significant correlations for adoptive siblings at 4 and 5 years. Hereditary influence is also suggested because nonadoptive sibling correlations are greater than adoptive sibling correlations and these differences are significant at 3 and 4 years.

Application of the sibling model described earlier indicates that shared environmental variance appears to increase during early childhood, from 18% at 3 years, to 26% at 4 years, and to 34% at 5 years. The average heritability estimate across the 3 years is .45.

Parent–Offspring Correlations

The greater sample sizes of the parent–offspring analyses and the direct estimate of genetic influence based on biological parents and their adopted-away offspring make these analyses more powerful than the sibling design. However, the results of the parent–offspring analyses can differ from the sibling analyses because parent–offspring analyses depend upon resemblance in television viewing between adult parents and their children at 3, 4, and 5 years of age, whereas siblings are studied at the same ages in CAP. Table 3 lists parent–offspring correlations for the three types of parents: biological parents and their adopted-away offspring, adoptive parents and their adopted children, and parents and offspring in nonadoptive families.

The parent–offspring results for television viewing at 3 years of age are equivocal. Although a significant resemblance emerges for nonadoptive mothers and fathers, suggesting either genetic or shared environmental influence, correlations for biological parents and their adopted-away children are relatively low, as are correlations for adoptive parents and their adopted children. At 3 years, average weighted parent–offspring correlations are .27 for nonadoptive parents, .03 for biological parents, and .08 for adoptive parents.

At 4 and 5 years, the parent–offspring results suggest both genetic influence and environmental transmission. Correlations for all three types of parents are significant. The average weighted correlation for biological parents and their adopted-away offspring is .17 at 4 years and .15 at 5 years. Because the coefficient of genetic relationship between parents and their offspring is .50, the correlation between the biological parents and their adopted-away offspring estimates only half of the genetic effect. Thus, the correlation between biological parents and their adopted-away offspring suggests that 34% of the variance of television viewing at 4 and 30% of the variance at 5 is due to genetic influences. Genetic transmission between parents and offspring can also be estimated by doubling the difference between correlations for nonadoptive and adoptive pairs. The average parent–child correlations are .26 for nonadoptive parents and .17 for adoptive parents at 4 years, and .26 and .17, respectively, at 5 years. This comparison suggests that 18% of the variance at 4 and 16% of the variance at 5 is due to parent-to-offspring genetic transmission, an estimate considerably lower than the direct estimate derived from biological parents and their adopted-away offspring. Both parent–offspring estimates of heritability are lower than those derived from the sibling design.

Environmental transmission from parent to child can be estimated from the correlation between adoptive parents and their children. Thus, environmental transmission from parent to child is estimated as .08 at 3, .17 at 4, and .14 at 5. This average estimate of .13 is lower than the average estimate of .26 from the sibling design.

Parent–Offspring Model Fitting

Table 4 lists parameter estimates and standard errors when the model described earlier was fit to observed covariance matrices for the adoptive and nonadoptive families. Inspection of the parameter estimates and their associated standard errors indicates that genetic influence (h) is significant at 3, 4, and 5 years of age. Variance in television viewing due to genetic transmission from parents to offspring (h^2) is estimated as 7% at 3, 13% at 4, and 12% at 5.

Environmental transmission from mother to offspring (m) is also significant at each year. Environmental transmission from parent to child can be estimated from the paths *me* and *fe* (and the negligible indirect paths *fpme* and *mpfe*) as .22 at 3, .22 at 4, and .19 at 5.

The other parameters were generally significant as well. Passive genotype–environment correlation (s) is significant at 3 and 4. Assortative mating is statistically significant for biological parents (q) as well as nonadoptive and adoptive parents (p). Some selective placement occurs for biological mothers (x_1 and x_2) but not for biological fathers (x_3 and x_4). This may be due to the relatively small sample of biological fathers, which is responsible for the large standard error for the x_3 and x_4 parameters.

Mediators of Genetic Influence

We explored IQ and personality as possible mediators of genetic influence on television viewing. At 3 the correlation between IQ and television viewing was −.01, and at 4 the correlation was .01. Thus, the sibling adoption design suggests that genetic influence on IQ is unlikely to explain genetic influence found for television viewing. The parent–offspring design suggests that parental IQ might influence children's television viewing, but for environmental rather than genetic reasons.

Table 4. *Maximum-likelihood parameter estimates for the CAP parent–offspring model for television viewing data at 3, 4, and 5 years*

Parameters	Year 3	Year 4	Year 5
h	.27 ± .13	.36 ± .10	.35 ± .10
s	.05 ± .02	.06 ± .02	.05 ± .18
m	.13 ± .06	.12 ± .06	.21 ± .06
p	.39 ± .04	.40 ± .04	.39 ± .04
q	.31 ± .11	.31 ± .11	.33 ± .11
x_1	.18 ± .06	.19 ± .07	.18 ± .06
x_2	.16 ± .07	.17 ± .07	.19 ± .07
x_3	.00 ± .16	.05 ± .16	.00 ± .16
x_4	.16 ± .13	.17 ± .13	.12 ± .14
f	.09	.11	−.02
e	.95	.91	.92
χ^2, 20 df	31.67	30.96	31.38

Correlations between parents' IQ and children's television viewing were negative: IQ for nonadoptive parents correlated −.13 with children's television viewing at 3, −.13 at 4, and −.10 at 5. Correlations between adoptive parents' IQ and children's television viewing were similar: −.16 at 3, −.17 at 4, and −.17 at 5. However, the correlations between biological mothers' IQ and their adopted-away children's television viewing were only −.01 at 3, −.03 at 4, and .08 at 5. This pattern of results suggests that parental IQ is associated environmentally, but not genetically, with children's television viewing. It is possible, for example, that higher-IQ parents restrict their children's television-viewing time to a greater extent than lower-IQ parents.

Similar analyses were conducted to explore possible temperament mediators of genetic influence on television viewing. The EASI traits correlated negligibly with television viewing. Across years 3, 4, and 5, the range of correlations was only −.08 to +.08. Other variables in the CAP were also examined but showed no systematic patterns of correlation with television viewing.

Together, these results suggest that genetic influence on television viewing is not explained by traditional measures of development such as IQ and temperament.

DISCUSSION

The results of this first adoption study of television viewing indicate that individual differences in children's television viewing are significantly affected by genetic factors as well as shared environmental influence. Both parameters tend to be greater for the contemporaneous relationship of siblings than for adult parents and their young offspring, which could reflect age changes in genetic and environmental influences (Plomin, 1986).

The finding that individual differences in television viewing are affected by shared rearing environment is not surprising, because it is reasonable to expect that parents model and facilitate television viewing for their children and that siblings enjoy some of the same television programs. Indeed, the surprising aspect of this finding is that shared environment only accounts for about 20% of the variance of children's television viewing.

The remarkable result is the evidence for significant genetic influence. The most impressive evidence for genetic influence comes from the significant resemblance between television viewing of biological parents and their adopted-away children. Although psychologists have become increasingly receptive to the possibility of genetic influence on behavior, genetic influence on individual differences in television viewing is likely to evoke residual reticence for at least two reasons. First, whether or not one watches television seems to be completely a matter of free will. We can click the set on or off as we please, so how can genes affect it? It is critical to recognize that genetic effects on behavior are not deterministic in the sense of a puppeteer pulling our strings. Genetic influences imply probabilistic propensities rather than hard-wired patterns of behavior. We can turn the television on or off as we please, but turning it off or leaving it on pleases individuals differently, in part due to genetic factors.

A second specious reason for reticence to accept the possibility of genetic influence on television viewing is that no obvious physiological mechanism suggests itself as the intermediary of genetic influence. In the domain of personality, for example, genetic influence on emotional reactivity is palatable because a plausible physiological mechanism, the autonomic nervous system, is apparent. In contrast, shyness is among the most heritable traits in personality (Plomin & Daniels, 1987), and yet it admits no simple physiological explanation. Nature is not kind to simple physiological hypotheses; intuitions about what should and should not be heritable are certainly no substitute for data.

It should be emphasized that finding significant genetic influence on time spent watching television in early childhood by no means implies that children's television viewing habits cannot be changed. The finding only implies that inherent proclivities of children are in part responsible for differences in the amount of time they choose to watch television. One implication for future research is to identify those characteristics of children that mediate this genetic influence. Our investigation of IQ and temperament suggests that genetic variance on these traits is not responsible for genetic influence on individual differences in television viewing. It is likely to be difficult to find specific mechanisms of genetic influence on television viewing because genetic mechanisms have not as yet been uncovered for any complex behavioral traits, including cognitive abilities and personality.

Another implication is relevant to the enormous research effort dedicated to understanding the consequences of television viewing. If television viewing is influenced by genetic factors, associations between television viewing and outcome variables might also be mediated indirectly by nature as well as nurture.

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