CHAPTER 7

Peers, Parents, and Processes of Adolescent Socialization: A Twin-Study Perspective

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CHALLENGES FROM AN EARLY TWIN STUDY

Thirty years ago, results from a landmark twin study, published as Heredity, Environment, and Personality (Loehlin & Nichols, 1976), challenged basic assumptions about the nature and nurture of behavior development. The study was of 850 adolescent twin pairs who so identified themselves among nearly 600,000 U.S. high school student participants in an annual national scholarship examination. The twins were neither a random nor representative sample, but comparisons to non-twins revealed no evidence of serious sampling bias, and these 1700 people comprised what was, at the time, one of the largest sample of twins ever studied, a study sufficiently large to permit novel analyses of the effects of heredity and environment on individual differences in adolescent behavior.

The Role of Heredity

The study’s findings about the important role of heredity in personality development created no surprise: genes matter, accounting for about half of the variance in major dimensions of self-reported personality. But the study’s findings about the role of the environment were more than merely surprising; they were truly puzzling.

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Friends, Lovers and Groups: Key Relationships in Adolescence. Edited by Rutger C.M.E. Engels, Margaret Kerr and Hakan Stattin. © 2007 John Wiley & Sons, Ltd.
The Role of the Environment

To the questions of whether, and how much, similarities and differences in parental treatment and childhood environmental experience influenced the similarities and differences of adolescent twin’s personalities, the surprising answer was: ‘not much.’ Environment ‘carries substantial weight in determining personality ... but that environment is one for which twin pairs are correlated close to zero’ (Loehlin & Nichols, 1976, p. 92). All correlations between the differences co-twins experienced in childhood and the differences in their adolescent personalities were near zero. Whether twins were dressed the same or differently, whether they played together as children or spent time together as adolescents, whether they were dressed alike or shared the same bedroom or had the same school teachers, whether their parents tried to treat them identically, or individually, seemed not to matter. Neither the frequency of parents’ discipline, nor the nature or amount of family interaction systematically related to the behavioral differences found between the twins. Differences in childhood treatment of adolescent twins failed to predict differences in their self-described personalities. And the personality differences observed between genetically identical co-twins, differences that must be due to differences in their environmental experiences, were no better predicted from measures of childhood treatment than the personality differences of fraternal co-twins, who are but half as alike, genetically.

At least for dimensions of self-reported personality, neither parental rearing practices, the home atmosphere parents created, nor differences in family structure and status influenced the relative similarity of adolescent co-twins.

More on the Effects of Environments

Three decades and hundreds of twin-family studies later, the challenges posed in the analyses of these 850 twin pairs remain important, provocative, and controversial. Publications over the last decade have popularized the notion that family and household influences are of limited effect in children’s development. In a book provocatively titled *The Limits of Family Influence*, David Rowe (1994) argued that environmental variables often held as influential in children’s behavior, variables such as social class and parental warmth, are of no causal influence on child outcomes. Four years later, Harris (1998) argued that parents matter less than do peers and that household environments are less relevant to children’s development than the school and neighborhood environments which adolescents experience outside their homes. A cover story in the popular press headlined the blunt question: ‘Do parents matter?’ (*Newsweek*, September 7, 1998). And a year later, another book’s subtitle asked: ‘Do Parents Really Shape their Child’s Personality, Intelligence, or Character?’ arguing not only that parenting has little influence on children’s outcomes, but that siblings show little more resemblance to one
another beyond that expected between age-matched and cohort-matched
genetic strangers (Cohen, 1999).

One version of the ‘Do parents matter?’ argument is that peers, not parents,
are the major source of environmental influence and that, accordingly, the
more relevant environment is found in schools and neighborhoods, not in
households. The more general, more controversial argument is that environ-
mental effects on behavior are almost entirely environmental effects unique to
individuals – that experiences shared by siblings while growing up together
have negligible effects on their resemblance. Both arguments are overstated
and misleading (Rose, 1995; Rutter, Pickles, Murray & Eaves, 2001).

Are the common experiences shared by siblings irrelevant to their beha-
vioral resemblance? Are differences in family environments of no consequence
to children? Is transmission of their genes the only influence parents have on
their children’s behavioral outcomes? By what processes are adolescents
influenced by the peers with whom they associate? How do adolescent select
their friends? What explains the behavioral similarities between adolescents
and their friends? And what role do parents and parenting behaviors play in
an adolescent’s behavioral development? These questions form the context for
this chapter review of the influence of peers and parents as agents in the social
development of adolescents. We selectively review the influence of peers and
parents from the perspective of recent twin-family studies, citing data from
two ongoing longitudinal twin-family studies conducted in Finland. These
FinnTwin studies were designed to assess behavioral precursors and conse-
quences of adolescent alcohol use and abuse; featuring multi-occasion, multi-
rater assessments and adding the twins’ parents, siblings, or classmates to the
sampling structure, the studies yield relevant results for evaluating processes
of influence from peers and parents.

Because peers must exert their influence on an adolescent within the context
of experiences they share with that adolescent, we reconsider effects of shared
environmental experience. And because such effects are difficult to demon-
strate in traditional twin comparison data, we consider other designs: studies
of non-biological siblings who are reared together and an extended twin study
design that yokes a gender-and age-matched classmate control to each twin. In
so doing, we ask whether effects of shared environments are to be found in
schools and neighborhoods as well as within households, in interactions with
peers, as well as with parents. We also evaluate evidence that reciprocal
sibling interactions modulate an adolescent’s genetic dispositions, and we
similarly ask whether the influences parents have on their children’s devel-
opment are to be found not in direct effects, but in interactions that modulate
their children’s dispositional tendencies.

NO EFFECTS OF COMMON ENVIRONMENT?

Begin with the comparisons Loehlin and Nichols made, 30 years ago. It is
important to understand that Loehlin and Nichols did show effects from
common environments in two behavioral domains. One was in the abilities measured by subtests from the National Merit Scholarship Qualifying Test. That common environment is an influential factor in individual differences in adolescent abilities has been demonstrated repeatedly. The second, more interesting dimension of behavior to yield strong effects of common experience was in a series of activities assessed via self-reports of observable behaviors. Included were participation in sports and musical events, religious activities, behaviors stereotypically associated with one gender but not the other, and with conventional attitudes of masculinity and femininity. Included also were adolescent patterns of smoking and drinking: using or abstaining from alcohol or smoking cigarettes, becoming intoxicated. For these activities, correlations for both identical and fraternal twins were significant and substantial, with only modest systematic differences between identical and fraternal twins.

So, to restate the matter: Loehlin & Nichols’s 30-year-old twin study found effects of common environment to be a significant source of individual variation in activities and abilities, but not in personality. Many subsequent twin studies have replicated this fundamental finding: substantial genetic variance in adolescent abilities and observable behaviors, but little or none for self-reported personality dispositions. Four caveats should be added. First, the comparative similarity of identical and fraternal twin pairs does not robustly evaluate effects of common environments. Traditional twin studies have limited power to detect influences from familial environments, because such effects are not directly measured; they are modeled as residual variance not fully explained by the twin’s differences in genetic resemblance. Such effects are more sensitively detected in other research designs, including studies of non-biological siblings, genetically strangers who are reared together. For example, significant effects of common environmental influence were found for body mass index when same-age unrelated siblings (‘virtual twin pairs’) were added to a standard twin study design (Segal & Allison, 2002). Second, effects of common environments are evident for some dimensions of self-reported personality (Rose, 1988). Third, even for personality dimensions for which conventional twin comparisons show little effect of common environments, comparisons of genetically-identical twins pairs who differ in duration of cohabitation or frequency of social contact after separation, yield such evidence. Such study of MZ twins is instructive. Duration of cohabitation of MZ twins prior to their separation and the frequency of their contact subsequent to their separation correlate with pairwise resemblance for many behaviors: co-twins who cohabit longer and those who maintain more frequent contact are more alike (Rose & Kaprio, 1988; Rose, Kaprio, Williams, Viken, & Obremski, 1990). Fourth, observational assessments of the behavior of children and adolescents, including behaviors that define temperament and personality, reveal sibling similarities too great to be attributed solely to their shared heredity; perhaps that result is not surprising, since observable behaviors are directly available to the reinforcing effects of child-rearing and community expectation. While self-reports by twin children and ratings by their parents often show very modest resemblance among DZ twins and
non-twin siblings, substantial sibling resemblance is evident in observable
behaviors rated by teachers and classmate peers. In a representative study of
children’s observable behavior, Lewin, Hops, Davis, & Dishion (1993) found
sibling correlations exceeding 0.60 for teacher-rated adjustment. And in
FinnTwin data, ratings from both classmate peers and classroom teachers
yielded correlations significantly greater than zero for both same-sex and
opposite-sex DZ co-twins for every one of 11 domains of behavior measured;
teacher ratings of SSDZ twin pairs yielded correlations narrowly ranging from
0.50 to 0.60 across the 11 dimensions of rated behavior (Pulkkinen, Kaprio, and
Rose, 1999).

Yet, it is true (indeed, it is an oft replicated finding) that social activities and
observable behaviors are more heritable than self-reported dispositions.
Perhaps the behavior for which effects of common environments are most
widely documented is the initiation of drinking and smoking.

ABSTINENCE/INITIATION OF SUBSTANCE USE

Familial but not Heritable

A consistent result from recent analyses of twin and family data is that
initiation of substance use is highly familial, but negligibly heritable (Hopfer,
Crowley, & Hewitt, 2003; Pagan, Rose, Viken, Pulkkinen, Kaprio, & Dick, 2005;
Rose & Dick, 2005). Whether or not an adolescent at a given age has initiated
drinking or smoking, or remains abstinent, is dominantly influenced by
shared environmental influences. In early and mid-adolescence, concordances
for that dichotomous status are equivalent across identical and fraternal twin
pairs and equivalent across same-sex and opposite-sex twins, yielding comp-
pelling evidence that the environments shared by twin siblings influence their
decision to remain abstinent or to initiate drinking. Data from the two
FinnTwin studies illustrate. At age 14 (Rose, Dick, Viken, Pulkkinen, & Kaprio,
2001), a minority (approximately 36%) of individual twins reported using
alcohol. The proportion of concordant twin pairs (pairs in which both co-twins
report using alcohol) was equivalent for genetically identical (monozygotic or
MZ) and fraternal or dizygotic (DZ) pairs, and equivalent, as well, between
DZ twin pairs of same- and opposite-sex. Analyses of these data found that
environmental factors shared by co-twins – including both their familial
household environment and the non-familial environments of peers, schools,
and neighborhoods – accounted for more than 75% of the variance in drinking
initiation in both boys and girls. In a parallel study of older adolescent Finnish
twins, first assessed at age 16 (Rose, Kaprio, Winter, Koskenvuo, & Viken,
1999), twice as many (approximately 75%) had initiated drinking but, again,
concordance did not differ across zygosity or twin type. Figure 7.1 illustrates
the equivalent concordance for initiation at the two ages; concordances are a
bit higher among sisters than among brothers, but differences between MZ
and DZ twins are negligible.
Equivalent concordances, such as those evident in Figure 7.1, have an unambiguous interpretation. Twin studies more readily establish environmental influences than those of heredity. Uncertain assumptions about equal exposure to relevant environments are always necessary to infer genetic variance from classic twin study comparisons. In contrast, results like these, showing equivalent resemblance across large and representative samples of MZ and DZ twins, permit the confident inference that heredity plays little or no role. So it is clear that shared environment is important in sibling similarity for drinking/abstaining. What do we know about the nature of that shared environment?

**Sibling Influences**

Some influences from shared experiences may be unique to siblings. How do experiences shared by siblings growing up together make them behaviorally alike? One way is via the siblings’ direct interactions. Effects of reciprocal sibling interactions were first suggested in sibling similarities for delinquency and substance use (Rowe & Gulley, 1992). Sibling relationships modulated sibling resemblance: same-sex siblings were significantly similar in their self-reported delinquency and substance use; brother-sister sibling pairs were not. And same-sex siblings who reported frequent interactions with mutual friends were much more alike ($r = 0.70$) than those whose peer networks were dissimilar ($0.26$). Parallel effects have been shown in adoptive siblings who share their environments, but not their heredity; correlations for patterns of alcohol involvement reported by 255 pairs of non-biological siblings were significantly higher in pairs of same sex and similar age, results interpreted as evidence that sibling environmental effects influence alcohol use via ‘social modeling or facilitation’ (McGue, Sharma, & Benson, 1996). Co-twin dependence importantly modulates genetic effects on their drinking patterns (Penninkilampi-Kerola, Kaprio, Moilanen, & Rose, 2005). Co-twin dependent
twins are more alike in several measures of alcohol use both in mid-
adolescence and in early adulthood, and shared environmental factors make
a more important contribution to their drinking patterns than is true for twins
not reporting dependence on their co-twin. Nor are sibling effects limited to
substance use. Common environmental effects on initiation of sexual inter-
course among adolescent same-sex siblings were highly significant, account-
ing for more than 40% of the variance among siblings in frequent contact; in
contrast, among brother-brother and sister-sister twin pairs whose contact was
limited, genetic effects were much stronger and influences from common
experience were negligible (Hunt & Rowe, 2003).

If the reciprocal effects of siblings are enhanced among sibs who are age-
matched and of the same gender, twin siblings can be expected to exert great
effects on one another through direct reciprocal social modeling. A formal
model of effects of cooperative sibling interaction was offered by Carey
(1986, 1992) and illustrated with data on criminality. In Carey’s model,
behavior of a twin influences that of the co-twin, and because twins’ behavior
is correlated, their reciprocal influences on one another result in more extreme
behavior in both co-twins. The behavioral variance in twins will be altered
according to the magnitude of their reciprocal interactions and the level of
covariance between them. For genetically influenced behaviors, MZ co-twins
will be more alike (because they are genetically more alike), and, in Carey’s
model, they will exhibit a greater shift in prevalence for the less common
of dichotomous outcomes. If the genetic effects are sex-limited, same-sex
pairs will be more alike and will show a greater shift in prevalence than
will brother-sister (opposite-sex or OS) pairs. Under usual assumptions,
cooperative social interaction effects will increase the prevalence of the more
extreme (i.e., the lower base-rate) condition in a dichotomous behavioral
outcome.

Specifically, among 16-year-old adolescents for whom drinking is non-
modal, sibling interaction will result in a greater prevalence of abstinence in
MZ than in DZ twin individuals, and a greater prevalence of abstinence in
SSDZ than among OSDZ twin individuals. Results for adolescent abstinence
rates from the Finntwin studies illustrate this. At age 16, the prevalence of
abstinence among all individual twin males was ordered MZ > SSDZ > OSDZ
to yield a chi square of 10.95, p < 0.01. In areas of northern Finland, where
access to alcohol is more limited and community surveillance is greater,
overall abstinence is more prevalent than in urban Helsinki; yet, the ordering
remained the same, and again the chi square was highly significant (Rose
et al., 1999). And there’s more: in Finnish culture, drinking patterns typically
include drinking to intoxication; only a minority (approximately 35%) of
individual Finnish twins who, at age 16, had initiated drinking reported
never having drunk to intoxication. The prevalence of that non-modal drink-
ing pattern was again ordered as predicted by Carey’s model of sibling
cooperation effects: MZ > SSDZ > OSDZ. Thus, both the initiation of drinking
and the initiation of intoxicating show evidence of cooperative sibling
interactions.
THE INFLUENCE OF FRIENDS: PEER SELECTION AND PEER
SOCIALIZATION

Another way shared experiences influence adolescent behavior is via the social
environments shared with peers. Adolescents resemble their friends, the peers
with whom they associate. For some adolescent behaviors, including patterns
of smoking, drinking, and delinquent misbehavior, friends resemble one
another about as much as do brothers and sisters. Because friends are genetic
strangers reared in different households, while siblings share half of their genes
and their household environment, the important question becomes: what
explains such significant resemblance among adolescent friends? In part, it
must reflect an active selection process (Rose, 2002) that is described below. We
like those who are like ourselves, and MZ twins, who are more alike, select as
their best friends, classmates more behaviorally similar to themselves than do
DZ co-twins. And, in part, friends resemble one another due to effects of
socialization. We come to resemble those with whom we associate, and
adolescent peers can be very influential social models. Patterns of substance
use in early adolescence appear to be especially sensitive to both processes –
active selection, in which an adolescent seeks to befriend those whose beha-
viors and attitudes are similar, as well as to the effects of socialization, social
modeling, and behavioral contagion. Some relevant results from Finnish twins
illustrate similarities in patterns of substance use among adolescent friends.

The 2nd wave questionnaire assessment in FinnTwin12 was made within
three months of each twin’s 14th birthday. At that age, nearly two-thirds of
all twins reported abstinence, 34% reported using alcohol infrequently, and
3% reported weekly drinking. We collapsed the categories of drinking and
classified each twin as abstaining or drinking at age 14 to assess the question:
What predicts whether a given adolescent is drinking or abstaining at age 14?
Significant predictors include accelerated pubertal maturation, externalizing
behavioral dispositions as rated by classroom teachers, and reduced parental
monitoring (Rose, Dick, Viken, Pulkkinnen, & Kaprio, 2001). But among the
most robust predictors is whether or not the adolescent reported having
friends who drink. Or smoke. Or use drugs. Or engage in delinquent acts

Behavioral Similarities Among Friends

Adolescents who report having friends who drink are much more likely to
drink themselves; having drinking friends is a potent predictor that an
adolescent drinks, one that yields nearly a seven-fold greater risk (an odds
ratio, OR, approaching 7.0). Having friends who smoke is also highly
predictive of whether or not a 14-year-old Finnish twin reports having
initiated drinking; that OR approached 5.0. Having friends who use drugs
yielded an OR > 4.0 and having friends who engage in delinquent behaviors
an odds ratio of nearly 3.0. Perhaps more surprisingly, having some friends of
the opposite sex (which characterizes only 30% of both 14-year-old twin boys and girls) yielded a three-fold risk.

**Gender Differences**

To add interest to this story: the predictive value of each of these effects is magnified among girls. Having friends who drink yields an OR > 8.0 for girls, against one < 6.0 among boys, and similarly for having friends who smoke, use drugs, or engage in delinquent behaviors: each report predicted drinking rather than abstaining better among girls than among boys. Further, the risk ratio for a twin sister who reports having friends of the opposite sex is substantially greater than is that report among age-matched boys. Perhaps a 14-year-old girl with friends of the opposite sex is a girl with accelerated pubertal maturation, and the association is with older male friends who, themselves, are more likely to be engaged in regular substance use.

A provocative result of analyses we earlier reported (Rose et al., 2001) was evidence that girls are more vulnerable to the consequences of reduced parental monitoring (vide infra). We now add evidence that girls are more vulnerable to the effects of associating with peers who smoke and drink (Holliday et al., 2005). Why should it be so? Perhaps reduced parental monitoring and associations with substance-using friends are more risk-enhancing for girls, because they are normatively more deviant. In Finnish data, girls report greater levels of parental monitoring than do boys. And, more interestingly, they do so within the same family (in comparisons of the amount of parental monitoring reported by brother-sister twin pairs). That the effects of reduced parental monitoring on drinking at age 14 are more salient for girls than for boys may be explained because it is more deviant for them. Is the same true for associating with deviant friends?

**HOW DO ADOLESCENTS SELECT THEIR FRIENDS?**

It has long been known that behavioral similarity plays an important role in friendship formation. And it does so at a very early age. The behavioral sociality of three- and four-year-old nursery school children, a rated index of their cooperative behavior derived from observational study, correlated more highly with friendship associations than measured IQ or other behavioral variables (Challman, 1932). In adolescence, behavioral similarity remains important for friendship formation. In a study of nominated best-school-friends among nearly 1900 high school adolescents, Kandel (1978) found significant similarities for measures of substance use (kappa = 0.40 for marijuana use, 0.34 for smoking, and 0.25 for drinking) consistent with the inference that behavioral similarity is an important factor in adolescent attraction. In a later study of adolescent best-friend dyads, (Kandel, Davies, & Baydar, 1990) similarity for substance use ranged from 0.25 to 0.45 for use of cigarettes, alcohol, sedatives,
stimulants, and other substances, and the analyses led to the conclusion that dyads form because of behavioral similarity and the dyads then grow to be more similar over time, a conclusion that both selection and socialization contribute to the observed similarities among adolescent friendships.

We focus on selection for several reasons. First, the evidence from studies of large samples using longitudinal designs (e.g., Ennett & Bauman, 1994; Fisher & Bauman, 1988) indicates that substance use similarities among adolescent friends reflect the effects of selection (similarity → attraction) more than effects of socialization (affiliation → similarity). Second, long-term longitudinal study of a birth cohort (Fergusson & Horwood, 1999) associated peer affiliations with prospectively measured familial, parental, and individual factors; results showed that peer affiliations are influenced by individual behavioral predispositions, as well as by social and familial factors. Given that most behavioral dispositions are moderately heritable, this longitudinal study suggests that friendship selection will exhibit genetic influences. And finally, we emphasize selection processes because the fact that adolescents form friendships to their liking, seeking out those who are similar to themselves, illustrates an important general result from twin study research: that within constraints of opportunity, people create their own social environments (Scarr & McCartney, 1983).

Twin Studies of Perceived Friendship Similarity

Are an adolescent’s friendship selections directly influenced by that adolescent’s genetic dispositions? Several studies of friendship selection using genetically-informative designs have focused on similarities that adolescent twins attribute to their friends (Grant, Bucholz, Madden, Slutske, & Heath, 1998; Manke, McGurie, Reiss, Hetehrington, & Plomin, 1995; Finntwin data reported in Rose, 2002). In this kind of study, twins (or non-twin siblings) are assessed on target behaviors and then asked to attribute to their best friends the same behaviors; in an alternate design used with young twins, the twins’ parents rate their twins and then attribute the same set of behaviors to their twins’ friends. Either design is easy to execute, but both invite systematic bias in the attributions of perceived similarity. But within their limitations, these studies suggest genetic dispositions influence adolescent peer formation. For example, MZ co-twins attribute to their peers greater similarity to their own patterns of smoking and drinking than do DZ co-twins, but it is uncertain whether peers of MZ co-twins are actually more alike or whether the twins only perceive them to be so. An alternate research design provides further insights.

A Twin Study of Actual Friendship Similarity

In a Finntwin study, we (Rose, 2002) explored genetic contributions to the similarities of adolescents and their friends in a design in which the behaviors of twins and their friends were assessed by classmate peers. Because
similarities of twins and their nominated friends were derived from assess-
ments from classmate peers, the design avoids the bias of attributed similarity.
School-based assessments of 1150 Finnish twin children, ages 11–12, included
a 33-item peer nomination procedure. For each of 33 behavioral attributes,
each child in the classroom nominated classmates who best fit the described
behavior (Pulkkinen, L., J. Kaprio, & R. J. Rose, 1999). That our research focus
was on the twin student(s) in the class was not mentioned. The last of the
33 items included in the peer nomination inventory asked each child to
nominate two classmates for the item: ‘Who are your best friends?’ Data
from that item permitted us to identify nominated best friends of MZ and DZ
twins and consider three research questions:

(1) Do MZ twins, more than DZ twins, tend to nominate one another and/or
common classmates as best friends? (2) Do twins identify as their best friends
classmates who are behaviorally similar to themselves? (3) Is the peer-rated
similarity of dyads formed from best friends of co-twins greater for best
friends of MZ twins? The data answer all three questions affirmatively.

And the results inform us how twins choose their classmate friends. Do twins
like those who are similar to themselves? We formed all possible dyads of each
twin and that twin’s nominated best friends. All correlations for all twin-friend
dyads were significant, ranging from 0.33 to 0.46 across the three factor scales of
the peer-nomination instrument. All were a bit higher for girls than for boys,
albeit with these modest samples, not significantly so. Yet, the pattern is
suggestive, for it was found not only for the factor scales, but for every one
of the individual scales that comprise the factors. Girls at this age are more
psychosexually mature than boys, and, as a result are often given more social
responsibility. Is assortative pairing (befriending those similar to one’s self)
more characteristic of 12-year-old girls as a result?

But caution is necessary: these correlations are inflated by the fact that
twins could – and did – nominate their co-twin as their best friend. Some
13% of the studied dyads were of co-twins. And that leads to the most
interesting question asked of these data: are friends of MZ co-twins behavio-
rally more alike than those of DZ co-twins? To answer it, we restricted the
nominated friends to independent dyads in which each twin nominated a
classmate not nominated by the co-twin, to yield a direct test of the influence of
shared genes and shared family environments in active friendship selection.
Independent classmate friends of co-twins will be alike if selection (assortative
pairing; Rose, 2002) characterizes adolescent friendships. And if assortative
pairing is influenced by genetic dispositions, friends of MZ co-twins will
be more alike than friends of DZs. Figure 7.2 confirms these expectations
with results for twin sisters and their best friends for items comprising scales of
anxiety and depression (which of your classmates are ‘shy,’ ‘lonesome, without
friends,’ ‘worry a lot,’ ‘are easily offended/start crying if someone is nasty to
them’). Under the usual assumptions, the relative similarity of the twin sisters
would parse nearly half of the variance in these behaviors to additive genes;
little surprise to that result. More interestingly, the relative similarity class-
mates attribute to the friends of MZ and DZ twin sisters also suggests genetic
effects – in this case, genetic effects on the friendship selections made by twin sisters at age 12. Similar results were found for items on the peer nomination inventory that load on scales of hyperactivity and aggression among girls. The samples are of modest size and, since this is the first study of its kind, caution is warranted; yet, the data do suggest that adolescent friendship selection is conditioned by genetic dispositions. Interestingly, parallel analyses for twin boys found no significant correlations in their nominated friendship dyads – another bit of suggestive evidence that assortative pairing may be weaker among boys at this age.

NON-FAMILIAL ENVIRONMENTAL EFFECTS

The influence of siblings and peers on an adolescent’s behavior makes evident the fact that shared environments are important, and that the relevant shared environment extends beyond that experienced within a family household. For adolescents especially, we need to consider the impact of environments which adolescents experience outside their homes – in their neighborhoods, schools, and communities. Neighborhoods affect children’s behavior above and beyond the children’s genetic liabilities. While genetically vulnerable families do tend to cluster in poorer neighborhoods, informative twin designs clearly suggest that the links between deprived neighborhoods and children’s behavior problems are a significant and real environmental effect (Caspi, A., Taylor, A., Moffitt, T.E. & Plomin, R., 2000). And neighborhood effects are found not only in poor neighborhoods, nor is the influence of neighborhoods found only on behavior problems. A novel sampling structure used in FinnTwin analyses will illustrate.

We studied 1262 same-sex twins at ages 11–12 and, for each twin, we added a gender- and age-matched classmate control (Rose, Viken, Dick, Bates, Pulkkinen, & Kaprio, 2003). The 631 families of twins resided throughout Finland; all twins and control children attended the public school serving their
residential area. In all but a handful of pairs, co-twins attended the same school, so the four children in each double-dyad, composed of a same-sex twin pair and their classmate controls, resided in the same neighborhood and attended the same school. This unusual sample enabled us to distinguish familial environmental effects from the school-based effects that each pair of classmate controls shared with each other and with the twins with whom they were yoked. Because the members of each twin-control dyad attended the same school, we label these extra-familial effects school-based (S), and our analytic model, FASE, distinguishes familial (F) and school-based (S) sources of shared environmental influence. The familial environment (F) is shared by both MZ and DZ co-twins, but it is not shared with unrelated classmates from the same neighborhood or school; in contrast, school-based neighborhood effects (S) are fully shared by all members of each double-dyad, each set of co-twins and their two school classmate controls. Thus, the effects of common experience latently assessed in ordinary twin comparisons are here differentiated into those experiences shared within families (F) and those shared in school-based environments (S) outside the family. The FASE model also includes additive (A) genetic effects and influences from each individual’s experiences (E) that are not shared with parents and siblings, as in conventional twin analyses.

The outcome variables we modeled with these data were a set of behavioral experiences scored dichotomously. Figure 7.3 illustrates results of our FASE model fit to two measures of smoking: ‘Have you ever smoked cigarettes?’ and ‘Do you have friends who smoke cigarettes?’ School-based shared environments (S) significantly contribute to individual differences in responses to both items, accounting for about a quarter of the total variance. Contrasting the model fits for the two items, familial environments are of more influence in determining one’s own smoking initiation, while genetic effects account for

![Figure 7.3](image-url)  
**Figure 7.3** Results of the FASE model for two smoking measures
more (more than 20%) of the variance in having friends who smoke – more
evidence that friendship formation in early adolescence is influenced, in part,
by genetic dispositions. At ages 11–12, smoking is more prevalent among boys
than girls; we added sex of each double dyad to the FASE model to differentiate
sex effects from estimates of S, and for one’s own smoking, 7% of the variance
was attributed to gender differences.

These results document significant non-familial environmental effects on
children’s behavior. The source of these non-familial effects must be variations
across communities, neighborhoods, and schools that have direct influence on
children’s behavioral development – differences in neighborhood cohesion
and community monitoring, access to alcohol and tobacco, regional differ-
ences in religious attitudes, and many other unidentified factors (Rose et al.,
2003). It is likely that the large neighborhood effects evident in these data may
be both behaviorally- and age-specific: substance use measures in early
adolescence may be behaviors particularly influenced by peers who share
experiences in school and neighborhood environments.

PARENTING EFFECTS ON ADOLESCENT BEHAVIOR
DEVELOPMENT

Do parents matter? Traditional research on parenting assumed, incorrectly,
direct and deterministic models of parenting effects. Such models assumed
uniform effects from patterns of parenting across all children. That assump-
tion is untenable. Children’s genetic dispositions influence their response to
parenting directives (Collins, Maccoby, Steinberg, Hetherington, & Bornstein,
2000). Children with different temperaments will differentially respond to
specific parenting practices, and effects of parenting behaviors will be modu-
lated by the temporal and contextual environments within which they are
experienced. Accordingly, we cannot pool parenting effects across families,
neighborhoods, and communities. Further, as made evident above, it is
important to distinguish familial effects that are experienced within house-
holds from non-familial influences experienced outside parent-child dyads.
Important aspects of extra-familial environments correlate with parenting
practices; e.g., selection of a neighborhood within which to reside is one
critical way parents influence their children’s peer experiences. Some of the
most significant contributions parents make to their children’s behavior
development are indirect, and the influences parents have on their adolescent
interact with influences of their adolescent’s peers.

Parents’ Influences on their Children

Consider again factors that predict whether a 14-year-old adolescent has
initiated drinking or remains abstinent. In addition to individual factors of
pubertal maturation and behavioral dispositions and social interactions with
peers and friends, differences in parenting practices and household environments are influential. In FinnTwin data obtained when the twins were age 14, the twins’ reports of parental monitoring, obtained two years earlier at age 12, were added into a logistic regression model with behavior ratings made by the twins’ teachers, pubertal development scores, and sex (as, at this age, more girls than boys have initiated drinking and sex differences interact with other predictive factors, including variation in parental monitoring). Figure 7.4 shows the proportion of Finnish twins at age 14 who reported using alcohol ordered by their ratings, made at age 12, of parental monitoring. Compared to the highest level of parental monitoring, the lowest levels of monitoring (caution: perhaps differences in monitoring are better construed as differences in child-disclosure; Stattin & Kerr, 2000) at age 12 are associated with a two-fold risk of drinking at age 14. Further, variation in parental monitoring interacts with dispositional differences and differences in pubertal maturation at age 14, and low parental monitoring is a greater risk factor for early-onset drinking among girls than among boys. For example, accelerated pubertal development in the context of the lowest level of parental monitoring is a potent risk factor for both boys and girls, such that more than 70% of these twins report drinking. But intermediate levels of parental monitoring seem to confer greater risk on girls than boys among those at or above the median in their pubertal development (Rose et al., 2001).

**Parenting Measures and Adolescent Substance Use**

Thus, Finnish data replicate reports by others that differences in level of parental monitoring reported by adolescent twins (or, reports independently

![Figure 7.4](image-url)
obtained from their parents) are significantly associated with abstinence/drinking in mid-adolescence. Reduced parental monitoring (caveat: again, perhaps it is reduced child-disclosure; Stattin & Keer, 2000) reported at age 12 is a risk factor for initiated substance use at age 14. But we find, as have others, that when assessed as direct effects, measures of parenting and household environment have but modest effect on adolescent behavioral outcomes. In an analysis of smoking initiation among 1642 same-sex Finnish twin pairs, the latent measure of common environment accounted for 70% of the variance, and when added into the analytic model, measured reports of parental monitoring accounted for but 2% of that total. But when parental monitoring was studied not as a direct effect, but as a moderating one (Dick, Purcell, Viken, Kaprio, Pulkkinen, & Rose, 2005) results revealed a much larger, albeit indirect, role for parenting; details follow.

Parental Effects as Moderators of Children’s Dispositions

If peers exert their influence on an adolescent by moderating the adolescent’s genetic dispositions, might not the influence of parents be similar? With FinnTwin data, we studied the role of several dimensions of parenting and household environment: monitoring, assessed by twins’ reports made at age 12; time spent with parents, from reports of twins at age 12; and two factors of parenting style, restrictiveness and nurturance, from a questionnaire completed by a parent in the baseline family questionnaire. The sample included 1642 pairs of same-sex twins, 812 MZ and 830 DZ. We used a G x E interaction model in which the values assumed by a measured moderator can alter the importance of genetic and environmental influences.

Results for parental monitoring illustrate (Dick et al., 2005). Across all same-sex twin pairs, the correlation of reported monitoring scores, derived from individual responses to three questions, was 0.53 – substantial agreement, but also substantial within-pair variation, in perceived monitoring by same-sex twin siblings. Accordingly, each twin’s monitoring measure was entered separately into the model: the value assumed by the moderator measure is allowed to change from one twin subject to another, reflecting the value of monitoring attributed by each individual. With this model, we first tested direct parenting effects and then asked whether monitoring has more complex effects on substance use, interacting with and moderating the importance of genetic and other environmental risk factors.

As expected, parenting effects were very modest; e.g., parental monitoring accounted for but 2% of the total variance. But monitoring had a very significant moderating influence on adolescent smoking in that, as monitoring increased, genetic effects linearly decreased and influences from common environment increased. The effect was dramatic: genetic effects accounted for 70% of the variance at the extreme of lowest monitoring, but only 15% of the variance at the highest level of monitoring. Conversely, common environmental effects accounted for less than 10% of the variance at the lowest level of
monitoring, but more than 80% at the highest level. Uncertainties over the
meaning of parental monitoring as here measured (Stattin & Kerr, 2000)
mandate a cautious interpretation of these results; it may the quality of the
parent–adolescent relationship, and not the nature of parenting practices, per
se, that is critical. But the results do suggest that aspects of parenting can
significantly moderate the expression of an adolescent’s genetic dispositions,
and aspects of parenting can play a significant role in adolescent substance
use. Parents’ behaviors offer models for their children, as well, and the effect
of parental models on adolescent substance use may be greater for some
children than others (e.g., Barman, Pulkkinen, Kaprio, & Rose, 2004).

Gene-Environment Correlations and Interactions

Analyses of FinnTwin data on adolescent drinking and its risk factors docu-
ment gene-environment interplay. Friendship selection appears to represent
important gene-environment correlations, as adolescents befriend those who
share similar dispositional tendencies, creating social environments in which
they are encouraged to express their behavioral dispositions and obtain their
social reinforcement. The initiation and the establishment of patterns of
smoking and drinking are influenced by genetic differences evident years
earlier in children’s behavioral dispositions, as well as in environmental
factors that influence exposure and access to alcohol and to models of drinking
behavior. Although our overall results indicate that drinking initiation is
primarily determined by environmental influences, while the establishment
of drinking patterns is determined mostly by genetic differences, the latter are
themselves subject to moderation by the environment. We have shown that a
traditional risk factor such as pubertal maturation is influenced in exquisite
environmental interactions. The within-family replication of the association of
accelerated pubertal maturation with earlier onset drinking is found only in
twin sisters residing in more urban environments within Finland. There are no
differences in within-family comparisons in more rural environments where
exposure is less likely, access is more limited, and peer models less prevalent.
Gene-environment interactions and correlations are central to understanding
patterns of substance use and abuse (Rose & Dick, 2005).

SUMMARY

This review is a selective one, both in its emphasis on substance use behaviors
and in its focus on twin studies conducted in Finland. But results from the
FinnTwin studies generalize to parallel epidemiological data from non-twins
and to results from adolescent twin studies conducted in other cultures.
Jointly, these studies provide evidence that shared experiences significantly
contribute to individual differences in patterns of adolescent substance use.
Both peers and parents exert influence on adolescent development, but such
influence is neither general, nor is it direct or uniform. The socializing effects of parents and peers are much more evident in some behavioral domains than others and at some ages than others. Influences of peers and parents are not uniform across different families, different neighborhoods, and different adolescents. Importantly, socialization effects of peers and parents are evident, not so much as main effects, but as processes that modulate the dispositional tendencies of adolescents. Some shared environmental effects are unique to the reciprocal interactions of siblings growing up together. Adolescent choose as their friends peers who are behaviorally similar to themselves, and such active selection processes are evident in the best-friend selections made by young adolescent twins. Selection may be more influential among girls than boys, and, in early adolescence, girls may be more vulnerable than boys to influences from both peers and parents.

We emphasize that some of the environmental effects we have described are behavior- and age-specific, and that substance use may be more sensitive to influences of peers, parents, and extra-familial environments than many other behaviors. But those cautions and caveats do not deny the major inference that at least for some years of adolescent development, and at least for some socially important behaviors, peers and parents exert significant influence of behavioral outcomes. Genetically informative research, including that with twins, their parents, and their peers, will offer new insights into the processes by which such influence is mediated.

ACKNOWLEDGEMENTS

The FinnTwin studies, which provide data reported in this chapter, have been supported by the National Institute on Alcohol Abuse and Alcoholism (grants AA 09203, AA 00145, AA 08315, and AA 12502), with supplementary funding from the Academy of Finland, the Finnish Centre of Excellence Programme, and the Yrjö Jahnsson Foundation; the studies are made possible through the collaboration of Professors Lea Pulkkinen, University of Jyväskylä, and Jaakko Kaprio, University of Helsinki.

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