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Examining transactional influences between reading achievement and antisocially-behaving friends

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Abstract

Background. The association between poorer academic outcomes and having antisocial friends is reliably demonstrated yet not well understood. Genetically sensitive designs uniquely allow for measuring the areas of genetic vulnerabilities and/or environmental risk in the association of antisocial friend behavior and poor school achievement, allowing for a better understanding of the nature of the association which is otherwise not available. **Methods.** The present study included 233 pairs of twins (mean age=10.71, SD=1.06) from the Florida Twin Project on Reading. First, the role of antisocial friends as an environmental moderator of reading comprehension was examined. Second, the role of reading comprehension as an environmental moderator of antisocial friends was examined. **Results.** In the first model, antisocial friends significantly moderated the nonshared environmental variance in reading comprehension, with increased variation at lower levels of association with antisocial friends. The genetic correlation in this model was -1.00 throughout the range of antisocial friend behavior, indicating substantial niche-picking. In the second model, reading comprehension significantly moderated the nonshared environmental variance in associating with antisocial friends, with increased variance at lower levels of reading comprehension. Additionally, there was a moderate and constant positive genetic correlation, indicating common genetic influences contributed to higher reading achievement and better-behaved friends. **Conclusions.** These results suggested reciprocal influences between reading achievement and antisocially-behaving friends. Antisocial friends appeared to be limited in the extent to which they can undermine reading achievement. At the same time, high reading achievement appeared to support less association with antisocial friends. Together, these results tell a mostly positive story concerning the transactional relation between

antisocial friends and reading achievement, and highlight that poor readers are the most at risk for associating with antisocial friends.

Keywords: Reading comprehension; G x E interaction; Antisocial friend behavior

Research indicates that children and adolescents who have high quality friendships are generally better-adjusted than those who do not have friends, or have poor quality friendships (Berndt, 1992; Nelson & DeBacker, 2008; Wentzel, Barry, & Caldwell, 2004). Further, the literature consistently shows that children and adolescents tend to become more similar to their friends in attitudes and behaviors over time (Berndt, Laychak, & Park, 1990; Kandel, 1978; Maxwell, 2002; Mounts & Steinberg, 1995). Longitudinal studies show that affiliating with deviant friends is related to increases in later deviant behavior, including aggression (Espelage, Holt, & Henkel, 2003; Snyder, Horsch, & Childs, 1997), antisocial behavior (Ary, Duncan, Duncan, & Hops, 1999; Dishion, Spracklen, Andrews, & Patterson, 1996; Patterson, Dishion, & Yoerger, 2000), and substance use (Barnes et al., 2006; Fergusson, Swain-Campbell, & Horwood, 2002).

Research has also examined the association of antisocial friend affiliation with achievement (Berndt, 1992; Ryan, 2000), with research suggesting affiliation with antisocial friends is associated with poor achievement outcomes, such as lower grades (Vitaro, Brendgen, & Wanner, 2005) and school dropout (Cairns, Cairns & Neckerman, 1989). Similar to the literature on the nature of the association of one's own antisocial behavior with achievement outcomes (Hinshaw, 1992), the nature of the association of antisocial friends with achievement outcomes is not clearly understood. Many studies have suggested that affiliating with antisocial friends leads to lower school achievement (Battin-Pearson et al, 2000; Fleming et al., 2005; Vitaro et al., 2005). This would suggest that antisocial friends present some sort of environmental risk which influences school achievement, perhaps through negative reinforcement of behaviors contrary to school success such as skipping class or not paying attention during class (Berndt, 1999). However, there is evidence that low school achievement

can instead lead to affiliation with antisocial friends (e.g., Dishion et al., 1991). This alternative would suggest that doing poorly in school presents an environmental risk of associating with antisocial friends, possibly by disenfranchising the youth from positive school role models, rejection by higher achieving friends and/or preferential selection by antisocial friends.

In general, previous work suggests that both directions of effect are possible: antisocial friends influence achievement outcomes and poor achievement outcomes influence antisocial friend association. However, not much is known about the forces underlying this association. Genetically sensitive designs uniquely allow for measuring the areas of genetic vulnerabilities and/or environmental risk in the association of antisocial friend behavior and poor school achievement, allowing for a better understanding of the nature of the association which is otherwise not available (Johnson, 2007). More specifically, twin studies use what is known about family relatedness to examine the genetic and environmental influences on traits or behaviors, and, importantly here, the G x E moderation model explores how these influences are moderated by environmental context (Purcell, 2002). By using this model, we can get some hint as to what sort of student is most vulnerable to antisocial friend influences and, alternatively, what sort of student is most at risk for affiliating with antisocial friends.

Using a twin sample of youth in Florida, we explored the association between antisocial friend behavior and reading comprehension achievement, an important indicator of school achievement (e.g., Slavin et al., 1989). We did this through two G x E moderation models. The first measured the extent to which genetic and environmental influences on reading achievement vary in the context of differing levels of antisocial friend behavior. This model served to describe the nature of how antisocial friends influence reading achievement. The second model measured the opposite situation, or how the genetic and environmental influences on antisocial

friend behavior varied in the context of differing levels of reading achievement. This model served to describe the nature of how reading achievement performance affected the association with antisocial friends.

Methods

Participants

The Florida Twin Project on Reading, Behavior and Environment (Taylor, Hart, Mikolajewski, & Schatschneider, 2012) is an ongoing cohort sequential study that ascertains progress monitoring and achievement data for reading from the Florida statewide educational database, Progress Monitoring and Reporting Network (PMRN). In addition, data concerning twin behavior and environment were obtained via a parent- and self-questionnaire (for children at least 9 years old only) mailed to families in 2010. For this report, all applicable data was used, but because the self-questionnaire was given only at a single time point to children aged 9 years and older, only a subset of children were available for analyses. In total, 118 monozygotic (MZ; 67 female-female pairs) and 115 same-sex dizygotic (DZ; 65 female-female) twin pairs were available with full data. Twins were in grades 4 through 7, and were on average 10.71 years old (SD=1.06yrs). According to parent report, 10% of the twins were African-American, 20% were Hispanic, 61% were Caucasian, and the remainder was mixed or other race/ethnicity.

Procedure and Measures

Twin zygosity was determined via a parental five-item questionnaire on physical similarity (Lykken, Bouchard Jr, McGue, & Tellegen, 1990; Taylor et al., 2012). Reading comprehension data were collected by trained administrators as part of statewide achievement testing required by normal school attendance, and test scores were uploaded into the PMRN via a web-based data collection system. For this report, reading comprehension data from the spring

of the 2009-2010 school year were used. The friends' data were collected via a self-questionnaire in the summer of 2010. All parents of twins completed an informed consent form approved by the Florida State University Institute Review Board allowing their children's achievement and questionnaire data to be used for this project.

Reading Achievement. Reading achievement was measured through the Florida Comprehensive Achievement Test (FCAT) reading subtest, a measure of reading comprehension. The FCAT is a group-administered test of multiple choice, short-answer or long-answer questions based on presented reading passages (Florida Department of Education, 2005). A Cronbach's alpha of .90 indicates the test has high internal reliability (Florida Department of Education, 2001). For this study, the IRT-based overall FCAT reading scale score was used, with a range of possible scores of 100 to 500.

Antisocial Friends. Each twin completed a 9-item antisocial behavior scale measuring aspects of his or her friends' delinquency (e.g., "my friends break the rules") or substance use (e.g., "my friends know where to buy drugs") drawn from a larger questionnaire created by the Minnesota Twin Family Study (Hicks, South, DiRago, Iacono, & McGue, 2009; Walden, McGue, Burt, & Elkins, 2004). Responses were based on a four-point Likert scale (1-4), from "none of my friends are like that" to "all of my friends are like that." The mean score across the nine items was used with higher scores representing association with more friends with antisocial behaviors (Cronbach's alpha=.77).

Analyses

As the antisocial friends scale scores and reading comprehension scores were continuous in nature and could vary within twin pairs, a continuous bivariate G x E moderation model was used to estimate the moderation effects (Purcell, 2002). For ease of explanation, the first model

representing associating with antisocial friends influencing the nature of reading comprehension will be used to further describe the analysis plan, although the model representing the other direction of influence was estimated as well. The G x E moderation model allows for the influences of additive genetic (inherited genetic influences; A), shared environment (environmental influences which make siblings similar; C) and nonshared environmental (environmental influences which make siblings unique, plus error; E) effects on reading comprehension to vary as functions of antisocial friends (see Appendix Figure 1). In this model, two sets of pathways are modeled for each source of variance: the genetic, shared environmental and nonshared environmental influences common to antisocial friends and reading comprehension and the genetic, shared environmental and nonshared environmental influences on reading comprehension alone. This allows potential genetic and shared and nonshared correlations between moderator and outcome to be modeled as well.

Significance of the presence of moderation as a whole was tested by constraining all moderation parameters to zero and evaluating the reduction of model fit in relation to the full moderation model. As the constrained model was nested in the full moderation model, a significant difference between the chi-squares of the full moderation and the constrained model was indicative of significant moderation. Various combinations of the individual moderation parameters of the A, C and/or E components were tested for significance by constraining the appropriate parameters to zero and comparing fits with those of the full moderation model (Purcell, 2002). These comparisons were done using the chi-square difference test as well as the Akaike's Information Criterion (AIC; Akaike, 1987) as an index of goodness-of-fit and parsimony. Although it is common in the literature to provide 95% confidence intervals around parameter estimates to determine significance of moderation effects, recent work has indicated

that this approach is inappropriate and inaccurate (Medland, Neale, Eaves, & Neale, 2009), so we present results from the model-fitting tests only. To control for age and sex effects, prior to model fitting, data were residualized on age, age-squared, sex, and sex by age as recommended by McGue and Bouchard (1984), and then z-scored. The model fitting was conducted using Mx (Neale, Boker, Xie, & Maes, 2006) with all available z-scored data.

Results

Descriptive Statistics

Descriptive statistics for reading comprehension and antisocial friends are presented in Table 1. The correlation between reading comprehension and antisocial friends was low but significant, r=-.10 (p=.03). Standardized univariate estimates of the genetic and environmental sources of variance in reading comprehension and antisocial friend behavior are presented in Table 1.

Antisocial friends as a moderator of variance in reading comprehension

Dropping all moderation parameters resulted in a significant change in fit from the full moderation model, indicating significant moderation by antisocial friends of variance in reading comprehension (-2LLΔ=13.34, dfΔ=6, p<.05; see Table 2). Given this, the next step was to explore individual moderation parameters. We first dropped all moderation on the common pathways. This did not significantly change model fit compared to the full moderation model, indicating that there was no significant moderation of the variance shared by antisocial friends and reading comprehension (2LLΔ=.86, dfΔ=3, p=ns). The moderating parameters on unique A and C variance could also be dropped, but the E-moderating parameter could not. Thus, the model including only moderation on unique E variance was selected as the best-fitting and most parsimonious model (overall fit, -2LL=3437.89, AIC=883.89, df=1277). As can be seen in

Figure 1, this model indicated that children who affiliated with fewer friends who showed antisocial behavior had more nonshared environmental variance, and therefore more total variance, on reading comprehension.

This model also estimated genetic and environmental correlations between antisocial friends and reading comprehension. The genetic correlation between antisocial friends and reading comprehension was -1.00, suggesting that, by the second half of elementary school, genetic influences on reading comprehension and association with antisocial friends were completely shared. Shared and nonshared environmental correlations were effectively 0.

Reading comprehension as a moderator of variance in antisocial friends

Dropping all moderation parameters resulted in a significant change in fit from the full moderation model, indicating significant moderation by reading comprehension of variance in antisocial friends (-2LLΔ=45.79, dfΔ=6, *p*<.05; see Table 3). Dropping moderation on all the common pathways did not significantly change model fit compared to the full moderation model, indicating that there was no significant moderation of the variance shared between the two constructs (2LLΔ=1.35, dfΔ=3, *p=ns*). Therefore, only combinations of moderation on the unique genetic and environmental pathways of antisocial friends were tested. Of these, the best-fitting model (i.e., the most parsimonious model with the lowest AIC) was the model indicating moderation on unique E variance only (overall model fit, -2LL=5731.41, AIC=1367.41, df=2182). As can be seen in Figure 2, this model indicated that for low-achieving readers there was more nonshared environmental variance in antisocial friends.

The genetic correlation between reading comprehension and antisocial friends was .36. Shared and nonshared environmental correlations were effectively 0.

Discussion

Previous work has suggested that children with more antisocial friends tend to have lower academic achievement (Berndt, 1999; Ryan, 2000), although the literature does not indicate a unitary causal direction. Instead, for some children, associated with antisocial friends appears to lead to low achievement outcomes, while for others, low achievement appears to lead to the association with antisocial friends. Given this, we explored how the genetic and environmental influences on reading achievement varied across levels of antisocial friend behaviors, and how genetic and environmental influences of antisocial friend behaviors varied with levels of reading achievement (Purcell, 2002). This allowed for a more specific understanding of the forces underlying the commonly reported association between affiliating with antisocial friends and achievement (Johnson, 2007).

The results from the main phenotypic correlation indicated a small association between antisocial friend behavior and reading achievement (r=-.10). All subsequent discussion needs to be considered in light of this small main effect. Results for the model exploring the role of antisocial friends as an environmental moderator influencing reading achievement indicated a significant moderation of the nonshared environmental variance in reading achievement. Specifically, there were greater nonshared environmental influences in reading achievement when children had fewer friends with antisocial behaviors, indicating reading achievement was more variable among those with fewer antisocial friends. The genetic correlation in this model was -1.00 throughout the range of antisocial friend behavior. This indicates substantial niche-picking, in that twins were associating with friends based on something about their genetically influenced reading achievement. This pattern of results suggested three conclusions. First, where there were direct influences of antisocial friend behavior on reading achievement, they appeared to be driven by those that acted to make twins within pairs different from each other. Second,

friends with fewer antisocial behaviors appeared to have a larger potential to influence reading achievement than having friends with more antisocial behaviors. Third, genetic influences contributing to having friends with fewer antisocial behaviors also contributed to higher reading achievement, though clearly not very directly.

This pattern of results may have been due to at least three, not mutually exclusive, possibilities. First, it may have reflected simply fewer, or smaller, friend influences on reading comprehension when friends were antisocial. If real, this suggests that either 'unfavorable environments' of friends with antisocial behaviors were more uniform in circumstance than more favorable environments, or that environmental unfavorability of any kind had similar influences on everyone, or both. A second possibility is that reading achievement in children with antisocial friends was less open to environmental circumstances. A third possibility is that since only a small proportion of children reported having antisocial friends, it is more likely that they have a smaller range of reading achievement simply due to the absolute number of children.

The second model explored the opposite causal direction, specifically the influence of reading achievement on variance in friend antisocial behaviors. For this model we do not mean to suggest that there might be a direct relation (i.e., that the behavior of the friends can be directly changed based on the reading skill of an individual). Instead, we modelled it this way to represent that struggling students sometimes disengage, or are socially marginalized away, from positive school environments, and thus end up in environments which run counter to school success (Johnson, McGue & Iacono, 2009). The results from this model indicated that there were greater nonshared environmental influences (and total variance) on friend antisocial behavior among poor readers. Additionally, there was a moderate and constant positive genetic correlation, indicating common genetic influences contributed to higher reading achievement and

better-behaved friends. Better readers had less variance in friends' antisocial behaviors than poorer readers, and as indicated by the negative phenotypic correlation, good readers were slightly less likely to pick friends with more antisocial behaviors. This indicates that there were fewer overall individual differences in friends antisocial behaviors in youth who are good readers, and the primary source of these individual differences are those effects that make twins different from each other.

The pattern of results from this model suggested two potential conclusions. First, the condition of being a good reader may simply be associated with less environmental vulnerability to associating with antisocial friends. This suggests that the variance in associating with antisocial friends is more open to environmental influence for poor readers. This could be due to good readers not typically being attracted to antisocial classmates or to being more readily accepted as friends by classmates who are not antisocial, resulting in less total variance, or it may be that good readers tend to be in contexts with fewer opportunities to associate with antisocial friends (e.g., better schools, higher-income neighborhoods). The second possibility is that poor readers are not only more likely to associated with antisocial friends, but also were more likely to answer the friends questionnaire with more variability, either because of their poor reading, or due to other unknown factors (e.g., more likely to exaggerate).

Across the two models, results would suggest that the association between antisocial friends and reading achievement was not shared within families. Rather, child-specific forces drove the association. To further support this, in this sample the twins reported not sharing many of the same friends (only 41% stated they shared "all or nearly all of our friends"). Also, there are important differences between the two models. When antisocial friends served as an environmental moderator of reading achievement, variance in reading achievement was greater

in the "better" environment of fewer antisocial friends. This was also in the context of a perfect negative genetic correlation, suggesting genetic influences contributing to having friends with fewer antisocial behaviors also contributed to higher reading achievement, although likely not directly. In the opposite model, the variance in friend antisocial behavior was greater in the "lesser" environment of poor readers. This would suggest that different, although complimentary, forces were at work depending on the context of the causal direction. When friends influenced reading, it was the better-behaving friends who had greater influence on reading achievement. This was coupled with the moderate positive genetic correlation. When reading achievement effects the association towards antisocial friends, better readers have less potential to associate with antisocial friends. Therefore, better-behaving friends were more likely to influence good readers (and more likely to be their friends), and good readers were less likely to associate with antisocial friends. This suggests that the students most at risk are poor readers, as they have a greater potential to associate with antisocial friends.

Limitations to this work need to be considered. The relatively young age of the sample resulted in few endorsements of antisocial friend behaviors. This work may not generalize to other developmental stages, especially the adolescent years where antisocial behaviors among friends tend to be more socially accepted and endorsed. Moreover, this work may not generalize to other samples, including samples of similarly aged children but with different socioeconomic stratifications or in different countries (e.g., Johnson et al., 2010). Another important limitation concerns the size of this sample. Although we had sufficient power to detect significant A or C moderations (e.g., power analysis indicated power of .87 for A moderation), the sample was small compared to similar work (e.g., Johnson et al., 2009). Finally, it may be the case that the

association between antisocial friend behavior and reading achievement was mediated by a variable not measured here, such as one's own antisocial behaviors (Wentzel & Caldwell, 1997).

Advances in modeling using genetically sensitive designs have increasingly been useful in understanding the complex nature of genetic and environmental sources of variance on childhood outcomes (Johnson, 2007). In both the research literature and the popular press, having antisocial friends is commonly associated with generally poor school outcomes. The present work adds to this literature in interesting ways, providing insight into the genetic and environmental transaction processes involved. Antisocial friends appeared to be limited in the extent to which they can undermine reading achievement. At the same time, high reading achievement appeared to support less association with antisocial friends. Together, these results tell a mostly positive story concerning the transactional relation between antisocial friends and reading achievement, and highlight that poor readers are the most at risk for associating with antisocial friends. These students are the most likely to benefit from targeted treatments.

Key points:

- Research has also examined the association of antisocial friend affiliation with achievement, with research suggesting affiliation with antisocial friends is associated with poor achievement outcomes, although the nature of the association is not known
- Genetically sensitive designs uniquely allow for measuring the areas of genetic vulnerabilities and/or environmental risk in the association of antisocial friend behavior and poor school achievement, allowing for a better understanding of the nature of the association which is otherwise not available
- Antisocial friends significantly moderated the nonshared environmental variance in reading comprehension, with increased variation at lower levels of association with antisocial friends. Conversely, reading comprehension significantly moderated the nonshared environmental variance in associating with antisocial friends, with increased variance at lower levels of reading comprehension.
- Together, these results tell a mostly positive story concerning the transactional relation between antisocial friends and reading achievement, and highlight that poor readers are the most at risk for associating with antisocial friends.

Table 1.

Descriptive statistics for reading comprehension and antisocial friends, as well as standardized

univariate estimates of genetic (A), shared environment (C) and nonshared environmental sources of

variance (E), including confidence intervals [in brackets]

Variable	Mean	SD	Min.	Max.	Skew	*n*	A	C	E
Reading comprehension	335.67	55.58	100	500	-.37	465	.55* [.42-.69]	.22* [.09-.34]	.23* [.19-.26]
Antisocial friends	1.27	.27	1.00	3.00	2.16	465	.00 [.00-.19]	.40* [.22-.51]	.59* [.51-.68]

Note. Significance is marked by *, reflecting 95% confidence intervals not including zero

Table 2.

Model fit statistics of models testing for moderation on reading comprehension by antisocial friends.

Model	-2LL	df	AIC	-2LLΔ	dfΔ	*p<.05
Full Moderation	3435.65	1272	891.65			
No Moderation	3448.99	1278	892.99	13.34	6	*
No Moderation on Common Paths	3436.51	1275	886.51	0.86	3	
Moderation on Unique C and E	3436.76	1276	884.76	1.11	4	
Moderation on Unique A and E	3436.55	1276	884.55	0.90	4	
Moderation on Unique A and C	3445.76	1276	893.76	10.11	4	*
Moderation on Unique A Only	3445.76	1277	891.76	10.11	5	
Moderation on Unique C Only	3447.42	1277	893.42	11.77	5	*
Moderation on Unique E Only	**3437.89**	**1277**	**883.89**	**2.24**	**5**	

A = additive genetic effects; C = shared environmental effects; E = non-shared environmental effects; AIC = Akaike's Information Criterion; -2LLΔ = chi-square change test between the reduced model and the full moderation model. The best-fitting model is indicated in bold type.

Table 3.

Model fit statistics of models testing for moderation on antisocial friends by reading

comprehension.

| Model	-2LL	df	AIC	-2LLΔ	dfΔ	*p<.05
Full Moderation	5727.43	2177	1373.43			
No Moderation	5773.22	2183	1407.22	45.79	6	*
No Moderation on Common Paths	5728.80	2180	1368.80	1.35	3	
Moderation on Unique C and E	5731.35	2181	1369.35	3.92	4	
Moderation on Unique A and E	5729.48	2181	1367.48	2.05	4	
Moderation on Unique A and C	5754.68	2181	1392.68	27.25	4	*
Moderation on Unique A Only	5759.19	2182	1395.19	31.76	5	*
Moderation on Unique C Only	5754.71	2182	1390.71	27.28	5	*
Moderation on Unique E Only	**5731.41**	**2182**	**1367.41**	**3.98**	**5**	

A = additive genetic effects; C = shared environmental effects; E = non-shared environmental

effects; AIC = Akaike's Information Criterion; -2LLΔ = chi-square change test between the

reduced model and the full moderation model. The best-fitting model is indicated in bold type.
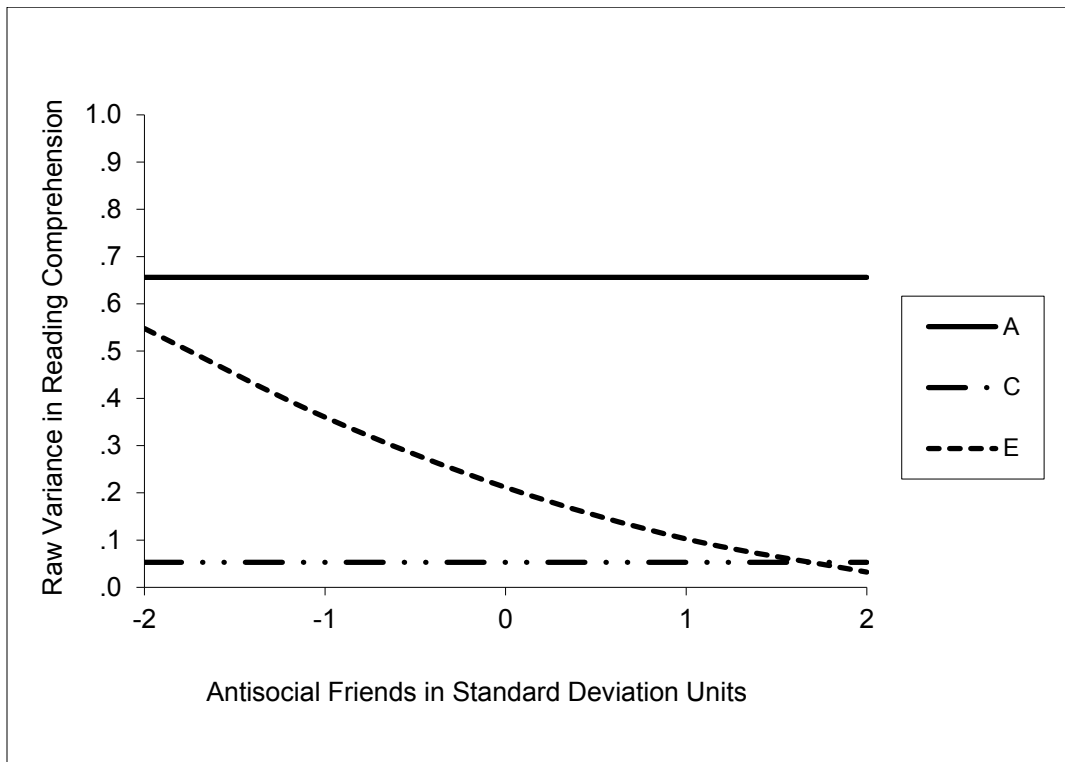
Figure 1. Raw (unstandardized) variance in reading comprehension as a function of antisocial friends by source of variance. A refers to additive genetic variance, C to shared environmental variance, and E to nonshared environmental variance.
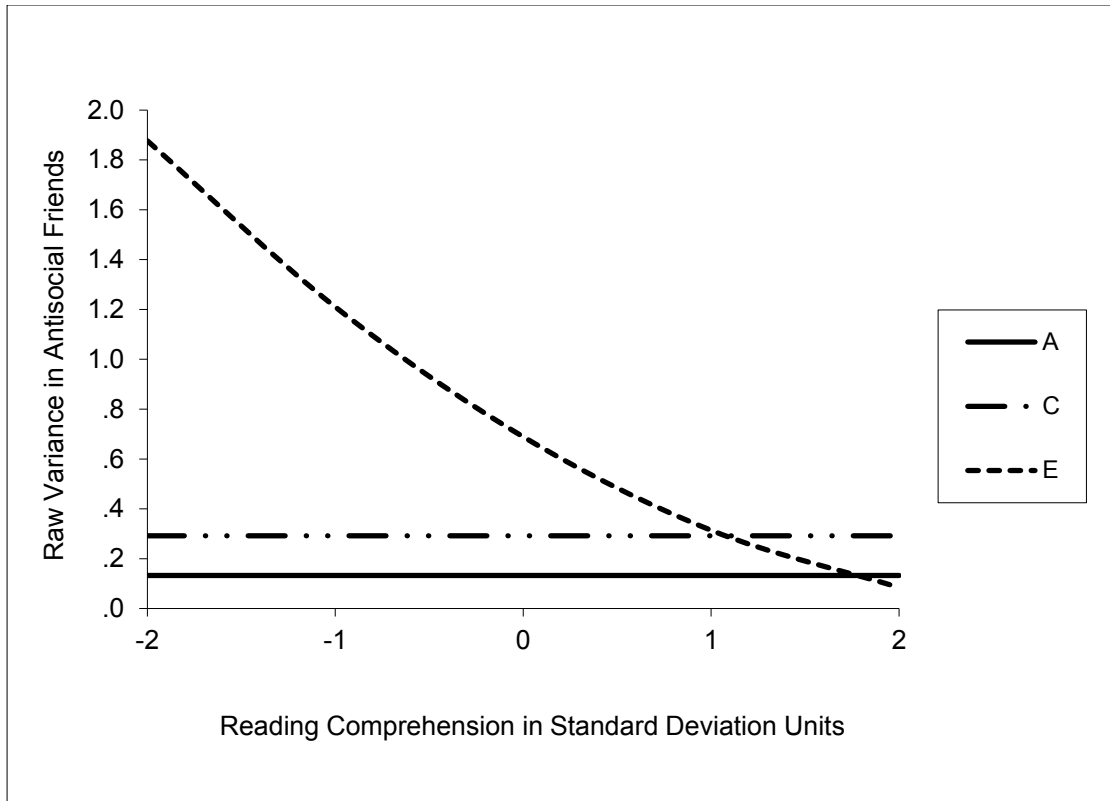
Figure 2. Raw (unstandardized) variance in antisocial friends as a function of reading

comprehension by source of variance. A refers to additive genetic variance, C to shared

environmental variance, and E to nonshared environmental variance.

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