A Longitudinal Investigation of the Associations Among Parenting, Deviant Peer Affiliation, and Externalizing Behaviors: A Monozygotic Twin Differences Design

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Non-shared parenting and deviant peer affiliation are linked to differences in externalizing behaviors between twins. However, few studies have examined these two non-shared environments simultaneously. The present study examined the transactional roles of differential parenting (i.e., warmth and hostility) and deviant peer affiliation on monozygotic (MZ) twin differences in externalizing behaviors using a two-wave longitudinal study of twins and their parents. The sample consisted of 520 pairs of MZ twins (46.5% males, 53.5% females), with a mean age of 13.86 years (SD = 2.10) at the T1 assessment, residing in Beijing, China. The association between non-shared hostility in parenting and adolescent externalizing behaviors was mainly explained by a child-driven effect whereby the twin with a higher level of externalizing behaviors than his or her co-twin was more likely to receive more hostility from the parents. Similarly, the relationship between deviant peer affiliation and adolescent externalizing behaviors supported the selection effect whereby the twin with a higher level of externalizing behaviors than his or her co-twin was more likely to affiliate with deviant peers. The theoretical and practical implications of these findings are discussed.

Keywords: non-shared environment, parenting, deviant peer affiliation, externalizing behaviors, twins

Siblings who are born and raised by the same parents are often remarkably different from one another, even for monozygotic (MZ) twins who have identical genetic makeup (Kendler, 1993; Plomin & Daniels, 1987; Rowe, 1981). Child-specific experiences that contribute to the uniqueness of each sibling are referred to as non-shared environment (Plomin & Daniels, 1987; Rowe, 1981). Child-specific experiences that contribute to the uniqueness of each sibling are referred to as non-shared environment (Plomin & Daniels, 1987; Rowe, 1981). In a recent review, Plomin and Daniels (2011) reiterated the important effect of non-shared environment on individual development. Since the seminal paper by Plomin and Daniels (1987), extensive efforts have focused on identifying the environment that is specific to each child and associating these non-shared experiences with sibling differences in developmental outcomes. Moreover, researchers have attempted to investigate the causal nature of the relationship between differential experiences and differences in siblings' behaviors (Plomin et al., 2001). However, rigorous testing of non-shared environmental influence is difficult because of the complex interplay between genes and environments, such as

gene–environment correlation and gene–environment interaction (Plomin et al., 1977; Rutter & Silberg, 2002). One way to address this challenge is through the MZ differences approach. This approach has proven to be an effective way to investigate non-shared environmental influence because reared-together MZ twins share 100% of their genetic materials and shared environment. Accordingly, differences between MZ twins are due to non-shared environmental influences (Burt et al., 2006; Deater-Deckard et al., 2001).

Differential parenting and deviant peer affiliation have been documented as two prominent non-shared environments that account for twins’ differences in externalizing behaviors.
The Transactional Model of Development

To further illuminate the pathways by which non-shared parenting, deviant peer affiliation, and sibling differences in externalizing problems are related, we used the transactional model of development (Sameroff, 1975) as our theoretical framework. According to the transactional model, the development of a child is a product of continuous bidirectional interaction of the child and the environment. Transactions between the child and the environment go beyond relationships between parents and children; children and their parents are also involved in many ecological settings that change and are changed by their participants, such as peer groups. This view is consistent with Bronfenbrenner’s (1979) bioecological theory, which suggests that the inter-relationships among multiple settings affect child development. Previous studies have focused on the bidirectional relationship between non-shared parenting behavior and twins’ differences in externalizing behaviors (Burt et al., 2006; Caspi et al., 2004) as well as the bidirectional relationship between non-shared deviant peer affiliation and twins’ differences in externalizing behaviors (Burt et al., 2009; Vitaro et al., 2011). However, to our knowledge, no study has focused on the relationship between parenting and deviant peer affiliation in terms of a non-shared environmental mediation effect in adolescence. Therefore, the current study addresses this gap in the literature by evaluating the bidirectional relationship between non-shared parenting behavior and non-shared deviant peer affiliation.
The Present Study

The aim of the current study was to examine the effect of non-shared environments on twins’ differential externalizing behaviors from a transactional perspective using a cross-lagged design. First, the reciprocal relationship was examined between non-shared parental warmth/hostility and twins’ differences in externalizing behaviors. Mounting evidence has indicated that child’s oppositional behaviors elicit conflicitive reactions from his or her parents (Anderson et al., 1986; Burt et al., 2005; Ge et al., 1996). Extending this finding further, we expected the child-driven effect was also evident in non-shared parent–child interactions; that is, the twin with more externalizing behaviors would elicit more parental hostility and less warmth than his or her co-twin. Second, the reciprocal relationship was examined between non-shared deviant peer affiliation and twins’ differences in externalizing behaviors. We expected to observe the social selection effect; we hypothesized that twins with more externalizing behaviors would affiliate with more deviant peers than their co-twins. Third, our examination explored the relationship between the two non-shared environments, that is, parenting and deviant peer affiliation in influencing twin differences in externalizing problems.

Method

Participants

The current investigation was based on the data from the Beijing Twin Study (BeTwist). The BeTwist is an ongoing longitudinal investigation of 1,387 families with one pair of school-aged twins residing in Beijing, China. Detailed information regarding sampling and recruitment is available in the study by Chen et al. (2013). The BeTwist consists of different types of twins, including MZ twins, same-sex dizygotic (DZ) twins, and different-sex DZ twins. Zygosity was determined by both zygosity questionnaire (Cohen et al., 1975; Goldsmith, 1991) and DNA testing. Approximately 10.5% of zygosity was identified by questionnaires, with a 90.6% predictive accuracy, and 89.5% of zygosity was identified by DNA (Chen et al., 2010). The present investigation is based on the first two waves of the BeTwist. The first wave of data collection (T1) was conducted in 2008–2009, followed by the second data collection (T2) in 2010–2011.

The analytical sample for this study focused on MZ twins who lived together, and 77.5% (520 out of 671 MZ twin pairs) of the MZ twins met the criterion. Therefore, the present study consisted of 520 same-sex MZ pairs (242 males, 278 females) who were reared together, and roughly 1.5 years after the T1 assessment, 396 (76.2% of the original sample) pairs of MZ participants completed the T2 assessment. There was no difference in behavioral problems or deviant peer affiliation between the twins who completed the T2 assessment and those who did not. However, those who did not complete the T2 assessment reported higher maternal hostility than those who completed the assessment ($t = 2.33, p < .01$). The age of participants in the current investigation ranged from 10 to 18 years, with an average age of 13.86 years (SD = 2.10) at the T1 assessment. Approximately 95.6% of the twins resided with both parents; 0.8% of them experienced parental separation, and 3.6% of them experienced parental divorce by the T2 assessment. Approximately 92% of the sample was Han Chinese, and 30% of the parents had a college degree or higher. The average age of mothers and fathers at T1 were 39.78 years (SD = 3.98) and 41.32 years (SD = 4.24), respectively. More than 90% of the families had an average or well-off family economic condition.

Measures

In each wave, mothers and fathers reported their own warmth and hostility toward each twin, and one of the parents reported the twins’ externalizing behaviors and deviant peer affiliation of both twins (approximately 67% of the reporters of the parent report were mothers). The adolescents reported their perceived maternal and paternal warmth and hostility, their own externalizing behaviors, and their deviant peer affiliation.

Parental warmth and hostility. At T1 and T2, mothers and fathers reported their own parenting behaviors (i.e., warmth and hostility) toward each twin, and each twin reported the parental warmth and hostility he or she received from the mother and the father. Parental warmth and hostility were measured via scales adapted from the Iowa Youth and Families Project (Conger et al., 1995). Using a 5-point scale ranging from 1 (never) to 5 (always), participants rated items intended to measure two dimensions of their mothers’ and fathers’ parenting: warmth and hostility. These measures of parental warmth and hostility have been used in previous studies conducted in the United States (Ge et al., 1996; Kim et al., 2003) and have been validated in a Chinese adolescent sample (Guo et al., 2011). Parental warmth (seven items, with Cronbach’s alpha ranging from 0.85 to 0.91 for mothers, fathers, and adolescents’ reports) measured the frequency with which parents expressed warmth and support toward their children. The correlation between adolescent-report and mother-report on this dimension was 0.37 ($p < .01$) and the correlation between adolescent-report and father-report was 0.36 ($p < .01$) at the T1 assessment. At the T2 assessment, these were 0.42 ($p < .01$) and 0.40 ($p < .01$), respectively. Parental hostility (six items, with Cronbach’s alpha ranging from 0.83 to 0.86 for three informants) indicated how often parents expressed specific negativity and anger toward their children. The correlation between adolescent-report and mother-report on this dimension was 0.36 ($p < .01$) and the correlation between adolescent-report and father-report was 0.34 ($p < .01$) at the T1 assessment. At the T2 assessment, these were 0.46 ($p < .01$) and 0.43 ($p < .01$), respectively.
In order to capture the unique information provided by different informants, the average scores of the adolescents’ and parents’ reports on parental warmth and hostility were used in the current study (see Burt et al., 2006). Then we subtracted the score of a randomly assigned twin from that of the co-twin to create the MZ differences scores for parental warmth and hostility for mothers and fathers.

**Externalizing behaviors.** The aggressive and delinquent subscales of the Youth Self-Report Inventory (YSR; Achenbach & Rescorla, 2001) were used to assess adolescents’ externalizing behaviors. On a 3-point scale of 0 (not true), 1 (somewhat or sometimes true), and 2 (very true or often true), adolescents indicated the extent to which they had committed specific behaviors in the past six months at the T1 and T2 assessments (α = 0.92 at both assessments). This measure was translated into Chinese and used widely in previous research (e.g., Leung et al., 2006). Parents responded to the Children Behavior Checklist (CBCL; Achenbach & Rescorla, 2001) to measure their children’s problem behaviors (α = 0.92 at both assessments). The correlations between adolescents’ and parents’ reports at the T1 and T2 assessments were 0.38 (p < .01) and 0.34 (p < .01), respectively. The average scores for the adolescents’ and parents’ reports of externalizing behaviors were computed, and these scores were used to create the twin differences score by subtracting a twin’s score from his/her co-twin’s score.

**Deviant peer affiliation.** Twins and parents reported deviant peer affiliation at T1 and T2 using an instrument adapted from the National Youth Survey (Elliott et al., 1989). Twins and their parents were instructed to provide ratings for each twin’s peer group, with items scored using a 3-choice response format (1 = none of my/my child’s friends are like that, 2 = just a few of my/my child’s friends are like that, 3 = most of my/my child’s friends are like that). Item ratings were summed to yield a score indexing deviant peer affiliation (15 items; e.g., ‘My friends fight with others’, ‘their friends run away from home’). The deviant peer affiliation scale demonstrated good consistency reliability (0.87 at T1 and T2 for adolescents’ reports; 0.89 at T1 and 0.86 at T2 for parents’ report). The correlations between adolescent report and parental report at the T1 and T2 assessments were 0.38 (p < .01) and 0.34 (p < .01), respectively. Similarly, the average scores for the self- and parental reports on deviant peer affiliation were used to create the twin differences score for deviant peer affiliation.

**Analytical Strategies**

We used AMOS 17.0 (Arbuckle, 2003) to fit the hypothesized models for the MZ differences approach (Figure 1). The full information maximum likelihood (FIML) raw data technique was used to account for missing data (Little & Rubin, 1987). The cross-wave, within-trait coefficients shown in Figure 1 (i.e., $b_{11}, b_{22}, b_{33}$) indexed the stability of twin differences in parenting behaviors, deviant peer affiliation, and externalizing behaviors over time while controlling for the cross-lagged contributions of other traits. The cross-lagged coefficients allowed us to determine whether the association between twin differences in parental warmth/hostility and externalizing behaviors was parent-driven ($b_{13}$) or child-driven ($b_{31}$) and whether the relationship between deviant peer affiliation and externalizing behaviors was a socialization effect ($b_{23}$) or a selection effect ($b_{32}$). The reciprocal relationships between non-shared parenting behaviors and deviant peer affiliation (i.e., $b_{12}, b_{21}$) were examined after controlling for both stability and any cross-lagged contributions of other traits. Modeling analyses were conducted on signed sibling differences, allowing us to evaluate the direction of any significant effects. For example, a positive cross-lagged coefficient suggests that the twin with more of one trait evidences more of the other (see Burt et al., 2009).
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Results

Descriptive Statistics

Means, standard deviations, and bivariate correlations of the study variables are presented in Tables 1 and 2. The twin differences in parental warmth and hostility showed moderate stability across two waves ($r = .17–.37, p < .01$). Twins’ differences in externalizing behaviors were also moderately stable over time ($r = .37, p < .01$).

Cross-Lagged Analyses

Table 3 shows the results for the interplay among differential parent-child relationships, deviant peer affiliation, and differential externalizing behaviors. First, twin differences in externalizing behaviors at T1 significantly predicted differential parental hostility at T2 ($b_{31} = 0.15–0.17, p < .01$) after controlling for stability and the relationship between differential parenting behaviors and differential externalizing behaviors longitudinally. Third, differential deviant peer affiliation at T1 marginally predicted differential parental hostility at T2 ($b_{31} = -0.01, p < .1$ for maternal hostility and $b_{31} = -0.001, p < .1$ for paternal hostility).

To examine the possibility of whether the aforementioned model functioned differently depending on the gender of the child, we conducted a series of multi-group cross-lagged models by gender. When we constrained the parameter estimates of interest across gender, the fit was good ($\chi^2(4) = 2.76–9.00$ for parental warmth/hostility, $ns$). This finding indicated that the non-shared interplay among parenting, deviant peer affiliation, and externalizing behaviors did not vary across gender of the twin.

Discussion

The aims of the present study were to explore the roles of two types of non-shared environments, parenting (i.e., warmth and hostility), and deviant peer affiliation in differentiating twins’ externalizing behaviors. This is one of the first attempts to apply a longitudinal MZ twin differences design to examine the transactions between non-shared environments and externalizing problems. The cross-lagged analyses revealed little evidence in support of the non-shared parental hostility and deviant peer affiliation as a cause of twin differences. Instead, the findings suggested that each twin creates his or her own unique environmental niche in family and peer contexts based on his or her pre-existing externalizing behaviors.

Child-Driven Effect and Selection Effect in Adolescence

The child-driven effect was evident between non-shared parental hostility and twin differences in externalizing behaviors in differentiating family and peer contexts based on his or her pre-existing externalizing behaviors.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Individual scores M</th>
<th>Individual scores SD</th>
<th>Individual scores n</th>
<th>Sibling differences scores M</th>
<th>Sibling differences scores SD</th>
<th>Sibling differences scores n</th>
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</thead>
<tbody>
<tr>
<td>M-warmth,T1</td>
<td>26.88</td>
<td>4.37</td>
<td>924</td>
<td>0.30</td>
<td>3.16</td>
<td>426</td>
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<tr>
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<td>14.36</td>
<td>3.46</td>
<td>945</td>
<td>0.06</td>
<td>2.33</td>
<td>444</td>
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<td>F-warmth,T1</td>
<td>23.14</td>
<td>4.72</td>
<td>899</td>
<td>-0.02</td>
<td>3.40</td>
<td>407</td>
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<td>F-hostility,T1</td>
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<td>3.45</td>
<td>917</td>
<td>0.20</td>
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<td>426</td>
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<td>26.25</td>
<td>4.44</td>
<td>950</td>
<td>-0.19</td>
<td>3.03</td>
<td>349</td>
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<td>M-hostility,T2</td>
<td>14.01</td>
<td>3.55</td>
<td>956</td>
<td>-0.24</td>
<td>3.24</td>
<td>345</td>
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<td>F-warmth,T2</td>
<td>24.65</td>
<td>5.07</td>
<td>917</td>
<td>-0.04</td>
<td>3.77</td>
<td>337</td>
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<td>F-hostility,T2</td>
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<td>3.55</td>
<td>935</td>
<td>-0.18</td>
<td>2.31</td>
<td>348</td>
</tr>
<tr>
<td>EXT_T1</td>
<td>7.07</td>
<td>5.31</td>
<td>945</td>
<td>0.05</td>
<td>3.79</td>
<td>441</td>
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<tr>
<td>EXT_T2</td>
<td>7.12</td>
<td>6.01</td>
<td>729</td>
<td>-0.03</td>
<td>4.57</td>
<td>345</td>
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<tr>
<td>Peer_T1</td>
<td>2.36</td>
<td>2.59</td>
<td>945</td>
<td>-0.12</td>
<td>2.27</td>
<td>450</td>
</tr>
<tr>
<td>Peer_T2</td>
<td>2.40</td>
<td>2.79</td>
<td>759</td>
<td>0.06</td>
<td>2.37</td>
<td>374</td>
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</table>

Note: M = mother; F = father; EXT_T1 and T2 = externalizing symptoms at T1 and T2 assessments; Peer_T1 and T2 = deviant peer affiliation at T1 and T2 assessments; EXT diferences_T1 and T2 = twin differences in deviant peer affiliation at T1 and T2 assessments; Peer differences_T1 and T2 = twin differences in deviant peer affiliation at T1 and T2 assessments; $p < .05$; $p < .01$.

TABLE 2

Correlations Among Twin Differences Scores on Parenting, Deviant Peer Affiliation and Externalizing Symptoms at T1 and T2 Assessments

<table>
<thead>
<tr>
<th>Measure</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. M-warmth,T1</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. M-hostility_T1</td>
<td>-0.24**</td>
<td>1.00</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. F-warmth,T1</td>
<td>0.45**</td>
<td>-0.14**</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>4. F-hostility,T1</td>
<td>-0.14**</td>
<td>0.45**</td>
<td>-0.26**</td>
<td>1.00</td>
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<td></td>
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<td></td>
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<tr>
<td>5. M-warmth,T2</td>
<td>0.23**</td>
<td>-0.10</td>
<td>0.24**</td>
<td>-0.13</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6. M-hostility,T2</td>
<td>-0.05</td>
<td>0.37**</td>
<td>0.01</td>
<td>0.21**</td>
<td>-0.14*</td>
<td>1.00</td>
<td></td>
<td></td>
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<tr>
<td>7. F-warmth,T2</td>
<td>0.19**</td>
<td>0.01</td>
<td>0.37**</td>
<td>-0.21**</td>
<td>0.52**</td>
<td>-0.07</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>8. F-hostility,T2</td>
<td>-0.06</td>
<td>0.18**</td>
<td>-0.02</td>
<td>0.17**</td>
<td>-0.10</td>
<td>0.22**</td>
<td>-0.21**</td>
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<td>9. EXT differences_T1</td>
<td>-0.15**</td>
<td>0.12**</td>
<td>-0.12**</td>
<td>0.19**</td>
<td>-0.06</td>
<td>0.17**</td>
<td>-0.02</td>
<td>0.12*</td>
<td>1.00</td>
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<td>10. EXT difference_T2</td>
<td>-0.02</td>
<td>0.10</td>
<td>-0.13**</td>
<td>0.10</td>
<td>-0.20**</td>
<td>0.12*</td>
<td>-0.14*</td>
<td>0.24**</td>
<td>0.37**</td>
<td>1.00</td>
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<tr>
<td>11. Peer difference_T1</td>
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<td>0.07</td>
<td>-0.15**</td>
<td>0.19**</td>
<td>-0.02</td>
<td>-0.04</td>
<td>-0.00</td>
<td>0.04</td>
<td>0.30**</td>
<td>0.17**</td>
<td>1.00</td>
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<tr>
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<td>0.08</td>
<td>-0.17**</td>
<td>0.01</td>
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<td>0.12*</td>
<td>0.51**</td>
<td>0.09</td>
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</table>
Non-Shared Environment Inside and Outside the Family

The current study generated several implications. First, studies of non-shared environments and children’s externalizing problems need to pay attention to the reciprocal effect between differential experiences and differential outcomes because these exist in a dynamic cycle. Second, researchers are encouraged to examine the interplay between different non-shared environments (e.g., family, peers) on adolescent development. As the transaction model suggests, non-shared environments in different contexts appear to be interactive, rather than independent. Acknowledgment of this complexity in the structure of multiple contexts may accelerate the progress in future studies of non-shared environmental influences.

Strengths and Limitations
Several methodological strengths bolstered the credence of the findings reported in this study. First, to our knowledge, this is the first study to examine relations between two different types of non-shared environments in a longitudinal study of MZ twins by considering their stability and relationship with externalizing behaviors. Second, data from multiple informants (i.e., father, mother, and twins) were used in this study to fully capture adolescent behaviors and the family environment.
However, several methodological limitations warrant caution in the interpretation of the results. First, our measure of deviant peer affiliation was based on questionnaires. Thus, it remains uncertain whether our measure reflected the twins’ differences in exposure to deviant peers who were not shared by the twins or the twins’ differences in perceptions of peers whom the twins shared. However, empirical evidence suggested that the individual perceptions of the environment are also important to development (Iannotti & Bush, 1992). Second, as mentioned, the origins of MZ twin differences in externalizing behaviors at T1 remain unexplored. Thus, future researchers should examine childhood precursors of MZ twin differences in externalizing behaviors. Third, only two waves of data were available for this study, making it difficult to delineate complex pathways among parenting, deviant peers, and the development of externalizing problems over an extended period. Fourth, the magnitude of effects observed in this study, albeit statistically significant, was rather modest. This limitation is important when translating the present results to a prevention or intervention framework. It should be emphasized, however, that effect sizes are plausibly and even necessarily small given the complexity in human behaviors (Ahadi & Diener, 1989).

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