FAMILIAL TRANSMISSION OF INTERNALIZING PSYCHOPATHOLOGY: A SIBLINGS-REARED-APART STUDY

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Abstract

Depression and Anxiety tend to run in families. The aim of this study is to explore the associations between child and parent internalizing symptoms using the siblings-reared apart design to disentangle genetic and environmental influences. Data was based on an extended adoption study that included both adoptive and birth families linked through adoption (149 adopted children and their adoptive mothers (n = 149) and adoptive fathers (n = 144), 149 biological siblings of the adopted child (reared apart by the birth parents) and their birth mothers (n = 147), and the birth fathers (n = 77). We tested for associations between parent depressive and anxiety symptoms and child internalizing symptoms within three triads: adoptive families (adopted child, adoptive mother, and adoptive father), birth families (birth home-reared sibling, birth mother, and birth father), and a cross-family triad (adopted child, birth mother, and birth father). We found that the parent-child association was the strongest within birth families where shared genes and environments are present, and there was no statistically significant association between parent and child internalizing symptoms in adoptive families.

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Familial Transmission of Internalizing Psychopathology: A Siblings-Reared-Apart Study

Understanding the etiology of internalizing behaviors (e.g., depression and anxiety symptoms) in childhood is fundamental in the prevention and early intervention for internalizing psychopathology. There is substantive evidence to posit that family history of psychopathology plays a crucial role in the development of psychopathology in children from an early age in which genetic and environmental pathways for potential transmission are operating within the family dynamic (Bolger & Patterson, 2001; Dadds & Roth, 2001; McCarty et al., 2005). This is likely why we see that internalizing psychopathology tends to cluster within families; children who were raised by parents who have psychopathological internalizing behaviors are at a greater risk of developing internalizing behavior problems themselves (Downey & Coyne, 1990; Natsuaki et al., 2014). However, the mechanisms underlying this familial clustering is complicated, most likely involving genetic and environmental influences working in conjunction. This study aims to parse environment and genetic influences on the familial resemblance in psychopathology to further explore the associations between parent and child symptoms of internalizing psychopathology.

Genetic and Environmental Pathway for Familial Transmission

One of the explanations for the familial clustering of internalizing psychopathology is genetic transmission. The heritability of depression and anxiety is moderate, ranging from around .30 to .40 (Sullivan et al., 2000). The nature of the overall genetic heritability of internalizing psychopathology is proposed to be polygenic, comprising of several genetic variants with small, individual effects that work in combination (Davies et al., 2019). Depression and anxiety have shown to have common genetic linkages which explains the comorbidity that is often observed (Axelson & Birmaher, 2001; Kessler et al., 2008; Mineka et al., 1998; Thapar &

McGuffin, 1997). The extent to which internalizing psychopathological symptoms are experienced varies significantly due to individual differences in genetic makeup (Kendler, 2008). Genetic inheritance from parents to offspring does not immediately translate to a child developing internalizing psychopathology, but rather genes contribute to the potential for its development and subsequent progression toward internalizing problems through childhood (Cummings et al., 2014).

Furthermore, family resemblance in internalizing psychopathology can also be explained, in equivalent respect, by environmental transmission (Natsuaki et al., 2014). Environmental factors have shown to have a significant role in the development of internalizing behaviors especially in early childhood (Gjone & Stevenson, 1997; Schmitz et al., 1994). A substantial amount of the literature has identified numerous environmental risk factors for depression and anxiety including childhood adversity (e.g., childhood maltreatment, parental conflict/divorce, and illness/death in the family; Kessler, 1997; McLaughlin et al., 2012; Miloyan et al., 2018; Nanni et al., 2012), low socioeconomic status (Bradley & Corwyn, 2002; Zhu et al., 2019), and low parental support and engagement (Bögels et al., 2001; Hopkins et al., 2013). The mechanism underlying how environmental factors affect physiology, initiating the onset of depression and anxiety likely involves learning, epigenetics, and endocrine abnormalities (Schmidt, 2007). The summation of this evidence provides us the framework for breaking down the varying family-level pathways that creates familial aggregation of internalizing psychopathology.

Siblings-Reared-Apart Design

A predominant number of previous studies that have explored the associations between parent and child depression and anxiety have widely been conducted within genetically-linked families (Lombardo & Motta, 2008; Lovejoy et al., 2000; Meadows et al., 2007). While these

studies are informative in identifying the familial resemblance, they cannot identify the sources of the resemblance because within families whose members are genetically related, the associations between the parental-provided environmental factors and the child's psychopathological symptoms may be confounded by shared genetic links (Plomin et al., 1977; Scarr & McCartney, 1983). One resolution to this limitation is the siblings-reared-apart design (Natsuaki et al., 2019; Leve et al., 2019). This quasi-experimental design occurs when a child is placed in an adoptive home soon after birth and reared by genetically-unrelated parents. Meanwhile, a biological sibling of the adopted child is reared separately by the birth parents. While the children are genetically-linked (shared genes range from 50% on average for full siblings and 25% on average for half siblings), the rearing parents of each sibling are different, and thus provide different rearing environments. Therefore, this study design allows not only the comparison between adoptive families (i.e., the adopted child, the adoptive mother, and the adoptive father) and birth families (i.e., the birth home-reared sibling, the birth mother, and the birth father), but also the inclusion of cross-family triads (i.e., the adopted child, the birth mother, and the birth father) in the comparisons. The evaluation of familial clustering of internalizing psychopathology within nuclear families and across extended families enhances the ability to tease apart genetic influences from the child rearing environment.

Current Study

The objective of our current study is to extend the body of literature on the roles of genetic and environmental factors in the familial clustering of internalizing psychopathology using a new approach—the siblings reared-apart design. By adopting the sibling-reared-apart design which allows the comparison of parent-child associations in two types of families with different genetic relatedness among family members, we aim to assess the associations between

parents' depressive and anxiety symptoms and the child's internalizing behaviors. Because previous work suggested that both genetic and environmental factors contribute to child internalizing psychopathology, we hypothesized that the association between the parents' depressive symptoms and child's internalizing behaviors would be significant amongst adoptive families, but the parent-child association would be stronger amongst birth families. Likewise, we would expect the same pattern in the associations to be observed between the parents' anxiety symptoms and the child's internalizing symptoms across each family type. Furthermore, in our cross-family triad comparisons, we also expected to see that the birth parents' depressive symptoms and anxiety symptoms to both be significantly associated with the adopted child's internalizing behaviors.

Method

Participants

The participants in our study were drawn from the larger sample pool of those in participation of the Early Growth and Development Study (EGDS)—an on-going, longitudinal adoption study that has followed adoption-linked family triads (i.e., birth mother and father when possible), adoptive parents, and adopted children through early childhood through mid-adolescence (Leve et al., 2019). The focus of this study is to examine the gene-environment interaction and its effects on child development. The families (N = 561) participating in this study were recruited from 45 adoption agencies across 15 states in the United States in collaboration with recruitment sites in four regions: The Mid-Atlantic, the West/Southwest, the Mid-West, and the Pacific Northwest. The EGDS extended the project to include the biological siblings of the original EGDS adopted children—the Early Parenting of Children (EPoCH) study

which uses a siblings-reared-apart design (Natsuaki et al., 2019; Leve et al., 2019). These biological siblings of the adopted child are reared by the birth parents of the adopted child.

This study is based on data from the siblings-reared-apart design. The sample in our current investigation consists of 149 adopted children (81 males, 68 females), 149 adoptive mothers, 144 adoptive fathers, 147 birth mothers, and 77 fathers in the birth homes (consisting of 47 genetically-related fathers and 30 genetically-unrelated stepfathers, but we will refer to this sample as "birth fathers" from here on for simplicity). Then additionally, our study also includes the data collected on a biological sibling of the adopted child reared apart by the birth parents (*N* = 149; 73 males, 76 females). Our birth home-reared siblings sample consisted of 28 full siblings and 121 half siblings. Our entire sample is then differentiated into three triads including two family types—adoptive families (adopted child, adoptive mother, and adoptive father) and birth families (birth home-reared sibling, birth mother, and birth father)—and a cross-family triad (adopted child, birth mother, and birth father).

The ethnic and racial makeup of our adoptive families consists of 77.8% Caucasian, 8.1% African American, 6.3% Hispanic/Latino, 5.9% multiracial, and 1.6% other. The average level education achieved by the adoptive parents was a 4-year college or university degree and their median household income was between $125,001 and $150,000. For birth families, the ethnic and racial makeup consists of 63.8% Caucasian, 20% African American, 9.1% Hispanic/Latino, 4.5% multiracial, and 1.5% other. The average level of education achieved by the birth parents was a high school degree and the median household income was between $25,001 and $40,000.

Measures

EGDS assessments for this study was conducted through questionnaires, reported on by the parents of each respective family type in a location most convenient for the parent. In our

sample, all measures were reported on by the parents when the adoptees and siblings were around the age of 7 years old (M = 7.31, SD = 0.36), ranging from 6.65 to 8.63 years old.

Child Internalizing Symptoms. The Child Behavior Checklist: Ages 6-18 (CBCL/6-18) is a 174-item questionnaire that is reported on by a parent or caregiver to assess the presence of emotional or behavioral problems in the child or adolescent (Achenbach & Rescorla, 2001). Using a 3-point scale (0 = "Not true" to 2 = "Very true"), adoptive parents rated their adopted child's behaviors within the past six months, and birth parents rated their birth child (i.e., the adoptee's biological sibling). This study uses Internalizing Broadband scale which taps onto the symptoms of internalizing psychopathology including symptoms of anxiety and depression, and somatic complaints. Reliability analyses for the CBCL/6-18 yielded an overall alpha of .95.

Bivariate correlation analysis indicated mothers and fathers' reports on CBCL were highly correlated (rs = .659, and .479, ps < .001 for birth and adoptive parents, respectively). Given the high magnitude of the interrater correlations, the scorings of mother and father reports were combined to create a child internalizing symptom score.

Parent Depressive Symptoms. The Center for Epidemiology Studies Depression Scale (CES-D; Radlof, 1977) is a self-reported questionnaire consisting of 20 items to measuring the rate of depressive symptoms that were experienced within the past week. Each item was rated on a 4-point scale ranging from 0 = "Rarely or none of the time (less than 1 day)" to 3 = "Most or all the time (5-7 days)." Respondents reported on statements including "I was bothered by things that usually don't bother me," "I thought my life had been a failure," and "I could not 'get going'" to characterize their depressive feelings. Items are scored at a value ranging from 0–3 with a score of 16 or higher indicating a clinically significant level of depressive symptoms (N =

34 birth mothers, 16 birth fathers, 15 adoptive mothers, and 5 adoptive fathers). The reliability of the CES-D was .89 for adoptive and birth mothers and .88 for adoptive and birth fathers.

Parent Anxiety Symptoms. The State-Trait Anxiety Inventory (STAI; Spielberger et al., 1983) is a 40-item, self-reported questionnaire that assesses and differentiates temporary state anxiety and long-term, general trait anxiety. Our analyses utilized the Trait Anxiety subscale of the STAI (20 items) to measure the prevalence of clinical-level anxiety amongst each parent of both family types because we are interested in stable, psychopathological-level tendencies to experience anxiety symptoms. In this questionnaire, parents indicated their feelings towards statements including "I feel nervous and restless," "I feel inadequate," and reverse-coded items such as "I feel satisfied with myself." All items are rated on a 4-point, Likert-type scale ranging from 1 = "Almost never" to 4 = "Almost always" to indicate how the respondent generally feels. Higher scores indicate higher levels of anxiety. The reliability analysis of the STAI revealed an alpha of .92 for birth and adoptive mothers and .91 for birth and adoptive fathers.

Analysis Strategy

First, to explore the means and associations among the study variables across adoptive and birth families, descriptive statistics, pair sampled t-tests, and bivariate correlations were computed. Next, a series of bivariate correlation analyses were conducted to evaluate genetic and environmental mechanisms in familial clustering of internalizing psychopathology. First, to quantify the environmental risk associated with exposure to depression of family members, we assessed the associations between parent depressive symptoms and child internalizing symptoms within adoptive families. Specifically, a bivariate correlation analysis was conducted between the adoptive mother's depressive symptoms and the adopted child's internalizing behaviors. Then the same analysis was run for the adoptive father's depressive symptoms and the adopted

child's internalizing behaviors. Second, parallel analyses were run within birth families to evaluate the associations between the birth mothers; and the fathers' depressive symptoms with their birth children's (i.e., the siblings of the adoptees) internalizing symptoms. This set of analyses yielded the estimates of the combined effects of genes and environment in familial clustering of internalizing psychopathology, which we typically see in genetically-related families. Finally, to estimate genetic influences, we conducted a cross-family analysis in which we examined the associations between the birth mothers' depressive symptoms and the adopted children's internalizing behaviors. We ran the same sequence of analyses for the investigation of the association between parental anxiety and child internalizing symptoms. As a supplementary analysis, we also conducted a similar set of analyses using data from the birth fathers, but readers are reminded that only 61% of fathers in the birth homes were biological fathers of adoptees and thus this analysis should not be interpreted as a rigorous test of genetic influences. The strength of bivariate correlations are compared using Fisher's r-to-Z transformation. All analyses were conducted using the IBM SPSS Statistics (Version 27) software.

Results

Descriptive Statistics

Table 1 shows the descriptive statistics amongst the study variables. Adopted children and their birth home-reared siblings had similar average ratings on the presence of internalizing behaviors (M = 4.59, SD = 3.79 and M = 4.69, SD = 4.59, respectively). Paired sample t-test found that there was no sibling difference in internalizing behaviors, $t(115) = .419$, $p = .676$. Amongst parents, the levels of depressive symptoms were higher for birth mothers (M = 10.99, SD = 9.64) than for adoptive mothers (M = 7.60, SD = 7.69), $t(114) = 2.25$, $p = .026$. However, there was no difference in anxiety symptoms between birth mothers (M = 37.04, SD = 10.47) and adoptive mothers (M = 35.05, SD = 8.63), $t(110) = 1.53$, $p = .128$. Then birth fathers (M = 11.56,

SD = 8.89) reported more depressive symptoms than adoptive fathers (*M* = 6.52, *SD* = 5.72), *t*(40) = 3.09, *p* = .004. Likewise, birth fathers (*M* = 38.07, *SD* = 9.58) also reported more anxiety symptoms than adoptive fathers (*M* = 33.54, *SD* = 7.74), *t*(38) = 2.38, *p* = .022. For adoptive families, depressive symptoms were significantly associated with anxiety symptoms for both adoptive mothers (*r* = .764, *p* < .001) and adoptive fathers (*r* = .612, *p* < .001). For birth families, there was also significant associations between depressive symptoms and anxiety symptoms for both birth mothers and birth fathers (*r*s = .773 and .801, *p*s < .001, respectively).

Table 1

Descriptive Statistics

	Internalizing Symptoms		
	N	Mean	SD
Adopted Child	116	4.48	3.72
Biological Sibling	149	4.68	4.57

	Depressive Symptoms			Anxiety Symptoms		
	N	Mean	SD	N	Mean	SD
Adoptive Mother	126	7.60	7.69	121	35.05	8.63
Adoptive Father	111	6.52	5.72	103	33.54	7.74
Birth Mother	138	10.99	9.64	138	37.04	10.47
Birth Father	55	11.56	8.89	55	38.07	9.58

Depressive Symptoms

Table 2 set shows the bivariate correlations amongst depressive symptoms across all three triads. In the birth families, we found that the birth home-reared sibling's internalizing symptoms was significantly correlated with the birth mother's depressive symptoms (*r* = .357, *p* < .001) and the birth father's depressive symptoms (*r* = .387, *p* = .004).

The same analyses were conducted on the adoptive family triads yielding differentiated findings. Interestingly, we did not find any significant association between the adopted child's internalizing symptoms and the adoptive mother's depressive symptoms (r = .134, p = .156). Likewise, there was no significant association with the adopted child's internalizing symptoms and the adoptive father's depressive symptoms (r = .093, p = .355).

Additionally, the cross-family correlation analysis conducted in comparing the adopted child's internalizing symptoms and the birth parent's depressive symptoms yielded mixed results. We found the that the adopted child's internalizing symptoms was marginally associated with the birth mother's depressive symptoms (r = .185, p = .058), but not associated with the father's depressive symptoms (r = .146, p = .339).

Table 2

Table of Correlations for Depressive Symptoms

	1	2	3
1. Adopted Child	--		
2. Adoptive Mother	.134	--	
3. Adoptive Father	.093	.178	--
	1	2	3
1. Biological Sibling	--		
2. Birth Mother	.357**	--	
3. Birth Father	.387**	.259	--
	1	2	3
1. Adopted Child	--		
2. Birth Mother	.185	--	
3. Birth Father	.146	.259	--

**. Correlation is significant at the .01 level (2-tailed).

A post-hoc Fisher's r-to-Z Transformation was then conducted to assess the significance of the difference between the correlation coefficients produced from the adoptive and birth families. We found that the associations of the child's internalizing symptoms and the mother's depressive symptoms were statistically different across two family types. Specifically, the mother-child association was stronger in birth families than adoptive families ($Z = 2.02$, $p = .043$). However, the father-child association was only marginally stronger within birth families compared to adoptive families ($Z = 1.82$, $p = .068$). However, our statistical power is likely limited given that the sample size of birth fathers is small ($n = 55$), therefore, this non-significant finding should be interpreted with caution.

A parallel post-hoc test was conducted to assess the statistical difference between correlation coefficients of the birth families and the cross-family triads. We found that there was no statistical difference between the significant associations of the child's internalizing symptoms and the mother's depressive symptoms across these two triads ($Z = 1.42$, $p = .156$). Additionally, while the association was significant between the father's depressive symptoms and the birth home-reared sibling's internalizing symptoms, but not the adopted child's internalizing symptoms, there was no statistical difference between these associations ($Z = 1.25$, $p = .211$).

Anxiety Symptoms

Table 3 set shows the bivariate correlations amongst anxiety symptoms across all three triads. Likewise to the previous finding in the birth family triads, we found significant associations between the birth home-reared sibling's internalizing symptoms and the birth mother's anxiety ($r = .381$, $p < .001$). The birth home-reared sibling's internalizing symptoms was also significantly associated with the birth father's anxiety ($r = .274$, $p = .045$).

Also likewise to the previous findings in the adoptive family triads, we did not find any significant association between the adopted child's internalizing symptoms and the adoptive mother's anxiety or adoptive father's anxiety (r = .111, p = .251, and r = .123, p = .240 for the adoptive mother and father, respectively).

Then in our analyses in comparing the associations of the adopted child's internalizing symptoms and the birth parents' anxiety, the results also revealed null findings. There was no significant association between the adopted child's internalizing symptoms and the birth mother's anxiety symptoms (r = .069, p = .481) or the birth father's anxiety symptoms (r = .246, p = .103).

Table 3

Table of Correlations for Anxiety Symptoms

	1	2	3
1. Adopted Child	--		
2. Adoptive Mother	.111	--	
3. Adoptive Father	.123	.153	--
	1	2	3
1. Biological Sibling	--		
2. Birth Mother	.381**	--	
3. Birth Father	.274*	.325*	--
	1	2	3
1. Adopted Child	--		
2. Birth Mother	.069	--	
3. Birth Father	. 246	.325*	--

**. Correlation is significant at the .01 level (2-tailed).

*. Correlation is significant at the .05 level (2-tailed).

Another post-hoc Fisher's r-to-Z Transformation was conducted to assess the difference in the parent-child associations between the two family types. We found that the associations of the child's internalizing symptoms and the mother's anxiety were statistically different ($Z = 2.23$, $p = .026$) in which the mother-child association was stronger amongst birth families compared to adoptive families, but there was no statistical difference between the two family types in the father-child association ($Z = 0.90$, $p = .368$).

Lastly, a similar post-hoc test was included to assess the statistical difference between parent-child associations of the birth families and the cross-family triad. We found that the associations of the child's internalizing symptoms and the mother's anxiety was statistically different ($Z = 2.53$, $p = .011$), indicating that the mother-child association was stronger within birth families than the cross-family triads. However, there was no statistical difference between the birth families and the cross-family triads in the father-child association ($Z = 0.14$, $p = .889$).

Discussion

Our evidence shows that the association between maternal depressive symptoms and internalizing symptoms was positively significant and stronger within birth families than within adoptive families. To our surprise, the mother-child association for depression was not significant within adoptive homes. These patterns of results indicate that the familial clustering of depression is likely better explained by the combination of, and the interplay between, genes and environment, rather than by environmental factors alone. The finding of parent-child positive association in birth families is consistent with previous work showing that children of depressed mothers are more likely to developing depression themselves by a two to threefold increase (Weissman et al., 2006) because family members within a birth family share both genetic and

environmental influences which coactively increases the risk for transmission (Loechner, et al., 2020).

Similarly, our evidence also shows that the mother-child association for anxiety symptoms was significant and found to be stronger in birth families compared to adoptive families. This evidence further supports the current literature that posits that anxiety is highly correlated between parents and children in the wake of shared genes and environments (Creswell & Waite, 2015; Franić et al., 2010; McLaughlin et al., 2008). Additionally, the mother-child association for anxiety symptoms was also found to be stronger in birth families compared to the cross-family triads. This finding may provide suggestive evidence of gene-environment coaction in anxiety transmission, supporting the studies that have found that the genetic link between parent and child anxiety is environmentally moderated (Ahmadzadeh et al., 2019; Eley et al., 2015). Overall, our findings indicate that the mechanisms for familial transmission of internalizing psychopathology are likely an intricate interplay of both genes and environment which cannot be easily disentangled into genes or environment. Future studies need to continue the effort to uncover how these factors are intertwined.

Additionally, it should be acknowledged that there was marginally significant evidence that the birth mother's depressive symptoms is associated with the adopted child's internalizing symptoms, alluding the possible genetic and prenatal influences in familial clustering of depressive symptoms. It also is noteworthy that this mother-child marginal association in cross-family triads was not statistically different from that of birth families. While we refrain from the over interpretation of marginal statistical significance, we speculate that this may be indicative of not only a genetic influence, but also a prenatal influence on the development of the child's internalizing psychopathology. One mechanism that may explain these findings, in conjunction

with heritability, is the exposure to stress hormones in utero as a result of maternal prenatal depression which has shown to negatively affect the child's temperament and emotional regulation by means of HPA dysregulation, elevating the risk for depression (Laurent et al., 2013; Waxler et al., 2011). Although, more research is needed to explore the prenatal environmental influence on the development of internalizing behaviors in children across non-shared environments.

The lack of association between parent and child internalizing psychopathology within adoptive families may need further examination. Because environment is an imperative determinant in the development of psychopathological behaviors (Singh et al., 2011), we expected to see some evidence for association between adoptive mothers and adopted children psychopathology. However, we did not observe any significant association between the adopted child internalizing symptoms and adoptive mother's depressive symptoms or anxiety symptoms in adoptive families. This is much in contradiction with the evidence that has demonstrated that the association between parent and child internalizing psychopathology is largely intertwined with environmental factors (Eley et al., 2015; McAdams et al., 2015; Tully et al., 2008). However, given that parental internalizing psychopathology is not only a risk for child internalizing problems, but also an overall risk for a child's psychosocial development in general (Goodman et al., 2011; Natsuaki, et al., 2014), we posit that future research should expand the exploration into these relationships to include multifaceted outcomes in children.

One of the unique features of this study is the inclusion of fathers. On the surface, the father-child associations for depressive and anxiety symptoms across all three triads reflect the same pattern found amongst the mother-child associations, evincing that the father-child association in internalizing psychopathology is most prominent within families that share genes

and environments. The important role of fathers in the familial clustering of internalizing psychopathology has increasingly become more recognized by researchers (Gibler et al., 2018; Gutierrez-Galve et al., 2015; van der Sluis et al., 2015), but still they remained highly understudied. In providing this evidence, we join the effort to emphasize the necessity to increase the inclusion of fathers to better our understanding of the familial transmission of internalizing psychopathology.

We found that the fathers' associations between depressive and anxiety symptoms and child internalizing symptoms was only significant in birth families compared to adoptive families and the cross-family triads, but the associations across all three triads were not significantly different. However, these finding should be considered with an appropriate degree of scrutiny. Given that our sample size of birth fathers is relatively small, our power to detect small differences between the father-child associations across all three triads is consequentially limited. Additionally, our father sample is further undermined by the extensive lack of genetically-related fathers in the birth homes.

Limitations and Future Directions

Our study is not without limitations. First, all our findings are correlational and thus we cannot be conclusive about the specific mechanisms and family dynamics that underly the familial transmission processes. Second, our study primarily focused on the symptoms each family member displayed and did not account for additional factors that may moderate the familial clustering. Future research should further explore factors that may play an important role in the transmission processes such as parent education (Davis et al., 2010), low income (Yoshikawa et al., 2012) and sole parenting (Fergusson et al., 2007). Third, as noted earlier, our sample of fathers in birth homes was small and represents a mix of birth and stepfathers of

children, which reduces our statistical power and interpretability in our birth father analyses. Fourth, with exception to anxiety symptoms amongst mothers, depressive and anxiety symptoms were generally higher within birth families compared to adoptive families. Future research should take account for the mean-level difference between two types of families. Fifth, our study used depressive and anxiety symptoms as an index for genetic transmission in our cross-family triad analyses but given that depression is a known risk factor for a number of psychopathologies (Anestis et al., 2008; Drabick et al., 2006) internalizing symptoms may not be sufficient as a genetic marker. Sixth, we analyzed mothers and fathers separately, but future research should address the family as one system, rather than compartmentalizing family members into small units of dyads. Lastly, the majority of our adoptive parent sample is Caucasian and in upper middle class and thus the generalizability of findings may be limited for more diverse populations.

Conclusion

With the rise of internalizing psychopathology amongst children and adults alike (Bitsko et al., 2019; Goodwin et al., 2020; Weinberger et al., 2018), it is important to further our understanding of the transmission of internalizing psychopathology within families. Using a broader, family-level approach in examining developmental psychopathology, our study provides evidence that the parent-child associations of internalizing behaviors are best explained by both genes and environment operating together in inseparable ways.

References

Achenbach, T. M., & Rescorla, L. A. (2001). *Manual for the ASEBA School-Age Forms and Profiles.* Burlington, VT: University of Vermont Research Center for Children, Youth, & Families.

Ahmadzadeh, Y. I., Eley, T. C., Leve, L. D., Shaw, D. S., Natsuaki, M. N., Reiss, D., Neiderhiser,2020 J. M., & McAdams, T. A. (2019). Anxiety in the family: A genetically informed analysis of transactional associations between mother, father and child anxiety symptoms. *Journal of Child Psychology and Psychiatry, 60*, 1269–1277. https://doi.org/10.1111/jcpp.13068

Anestis, M. D., Holm-Denoma, J. M., Gordon, K. H., Schmidt, N. B., & Joiner, T. E. (2008). The role of anxiety sensitivity in eating pathology. *Cognitive Therapy and Research, 32*(3), 370–385. https://doi.org/10.1007/s10608-006-9085-y

Axelson, D. A., & Birmaher, B. (2001). Relations between anxiety and depressive disorders in childhood and adolescence. *Depression and Anxiety, 14*(2), 67–78. https://doi.org/10.1002/da.1048

Bitsko, R. H., Holbrook, J. R., Ghandour, R. M., Blumberg, S. J., Visser, S. N., Perou, R., & Walkup, J. T. (2018). Epidemiology and impact of health care provider-diagnosed anxiety and depression among us children. *Journal of Developmental and Behavioral Pediatrics, 39*(5), 395–403. https://doi.org/10.1097/DBP.0000000000000571

Bögels, S. M., van Oosten, A., Muris, P., & Smulders, D. (2001). Familial correlates of social anxiety in children and adolescents. *Behaviour Research and Therapy, 39*(3), 273–287. https://doi.org/10.1016/S0005-7967(00)00005-X

Bolger, K. E., & Patterson, C. J. (2001). Developmental pathways from child maltreatment to peer rejection. *Child Development, 72*(2), 549–568. https://doi.org/10.1111/1467-8624.00296

Bradley, R. H., & Corwyn, R. F. (2002). Socioeconomic status and child development. *Annual Review of Psychology, 53*, 371–399. https://doi.org/10.1146/annurev.psych.53.100901.135233

Creswell, C., & Waite, P. (2015). The dynamic influence of genes and environment in the intergenerational transmission of anxiety. *American Journal of Psychiatry 172*(7), 597–598. https://doi.org/10.1176/appi.ajp.2015.15040509

Cummings, C. M., Caporino, N. E., & Kendall, P. C. (2014). Comorbidity of anxiety and depression in children and adolescents: 20 years after. *Psychological bulletin, 140*(3), 816–845. https://doi.org/10.1037/a0034733

Dadds, M. R., & Roth, J. H. (2001). *Family processes in the development of anxiety problems.* In M. W. Vasey & M. R. Dadds (Eds.), *The developmental psychopathology of anxiety* (p. 278–303). Oxford University Press. https://doi.org/10.1093/med:psych/9780195123630.003.0013

Davies, M. R., Kalsi, G., Armour, C., Jones, I. R., McIntosh, A. M., Smith, D. J., Walters, J. T. R., Bradley, J. R., Kingston, N., Ashford, S., Beange, I., Brailean, A., Cleare, A. J., Coleman, J. R. I., Curtis, C. J., Curzons, S. C. B., Davis, K. A. S., Dowey, L. R. C., Gault, V. A., … Breen, G. (2019). The Genetic Links to Anxiety and Depression (GLAD) Study: Online recruitment into the largest recontactable study of depression and anxiety. *Behaviour Research and Therapy, 123*, 103503. https://doi.org/10.1016/j.brat.2019.103503

Davis, E., Sawyer, M. G., Lo, S. K., Priest, N., & Wake, M. (2010). Socioeconomic risk factors for mental health problems in 4-5-year-old children: Australian population study. *Academic Pediatrics, 10*(1), 41–47. https://doi.org/10.1016/j.acap.2009.08.007 ·

Downey, G., & Coyne, J. C. (1990). Children of depressed parents: An integrative review. *Psychological Bulletin, 108*(1), 50–76. https://doi.org/10.1037/0033-2909.108.1.50

Drabick, D. A., Gadow, K. D., & Sprafkin, J. (2006). Co-occurrence of conduct disorder and depression in a clinic-based sample of boys with ADHD. *Journal of Child Psychology and Psychiatry, 47*, 766–774. https://doi.org/10.1111/j.1469-7610.2006.01625.x

Eley, T. C, McAdams, T. A., Rijsdijk, F. V., Lichtenstein, P., Narusyte, J., Reiss, D., Spotts, E. L., Ganiban, J. M., & Neiderhiser, J. M. (2015). The intergenerational transmission of anxiety: A children-of-twins study. *American Journal of Psychiatry, 172*(7), 630–637. https://doi.org/10.1176/appi.ajp.2015.14070818

Fergusson, D. M., Boden, J. M., & Horwood, L. J. (2007). Recurrence of major depression in adolescence and early adulthood, and later mental health, educational and economic outcomes. *British Journal of Psychiatry, 191*, 335–342. https://doi.org/10.1192/bjp.bp.107.036079

Franić, S., Middeldorp, C. M., Dolan, C. V., Ligthart, L., & Boomsma, D. I. (2010). Childhood and adolescent anxiety and depression: Beyond heritability. *Journal of the American Academy of Child and Adolescent Psychiatry, 49*(8), 820–829. https://doi.org/10.1016/j.jaac.2010.05.013

Gibler, R. C., Kalomiris, A. E., & Kiel, E. J. (2018). Paternal anxiety in relation to toddler anxiety: The mediating role of maternal behavior. *Child Psychiatry and Human Development 49*, 512–522. https://doi.org/10.1007/s10578-017-0771-7

Gjone, H., & Stevenson, J. (1997). A longitudinal twin study of temperament and behavior problems: Common genetic or environmental influences? *Journal of the American Academy of Child & Adolescent Psychiatry, 36*(10), 1448–1456. https://doi.org/10.1097/00004583-199710000-00028

Goodman, S. H., Rouse, M. H., Connell, A. M., Broth, M. R., Hall, C. M., & Heyward, D. (2011). Maternal depression and child psychopathology: A meta-analytic review. *Clinical Child and Family Psychology Review 14*, 1–27. https://doi.org/10.1007/s10567-010-0080-1

Goodwin, R. D., Weinberger, A. H., Kim, J. H., Wu, M., & Galea, S. (2020). Trends in anxiety among adults in the United States, 2008-2018: Rapid increases among young adults. *Journal of Psychiatric Research, 130*, 441–446. https://doi.org/10.1016/j.jpsychires.2020.08.014

Gutierrez-Galve, L., Stein, A., Hanington, L., Heron, J., & Ramchandani, P. (2015). Paternal depression in the postnatal period and child development: Mediators and moderators. *Pediatrics, 135*(2), e339–347. https://doi.org/10.1542/peds.2014-2411

Hopkins, J., Lavigne, J. V., Gouze, K. R., LeBailly, S. A., & Bryant, F. B. (2013). Multi-domain models of risk factors for depression and anxiety symptoms in preschoolers: Evidence for common and specific factors. *Journal of Abnormal Child Psychology, 41*(5), 705–22. https://doi.org/10.1007/s10802-013-9723-2

Kendler, K. S. (2008). Explanatory models for psychiatric illness. *American Journal of Psychiatry, 165*(6), 695–702. https://doi.org/10.1176/appi.ajp.2008.07071061

Kessler, R. C. (1997). The effects of stressful life events on depression. *Annual Review of Psychology, 48*, 191–214. https://doi.org/10.1146/annurev.psych.48.1.191

Kessler, R. C., Gruber, M., Hettema, J. M., Hwang, I., Sampson, N., & Yonkers, K. A. (2008). Co-morbid major depression and generalized anxiety disorders in the National Comorbidity Survey follow-up. *Psychological medicine, 38*(3), 365–374. https://doi.org/10.1017/S0033291707002012

Laurent, H. K., Leve, L. D., Neiderhiser, J. M., Natsuaki, M. N., Shaw, D. S., Harold, G. T., & Reiss, D. (2013). Effects of prenatal and postnatal parent depressive symptoms on adopted child HPA regulation: Independent and moderated influences. *Developmental Psychology, 49*(5), 876–886. https://doi.org/10.1037/a0028800

Leve, L. D., Griffin, A. M., Natsuaki, M. N., Harold, G. T., Neiderhiser, J. M., Ganiban, J. M., Shaw, D. S., Reiss, D. (2019). Longitudinal examination of pathways to peer problems in middle childhood: A siblings-reared-apart design. *Development and Psychopathology, 31*(5), 1633–1647. https://doi.org/10.1017/s0954579419000890

Leve, L. D., Neiderhiser, J. M., Shaw, D. S., Ganiban, J., Natsuaki, M. N., & Reiss, D. (2013). The Early Growth and Development Study: A prospective adoption study from birth through middle childhood. *Twin Research and Human Genetics*, *16*(1), 412–423. https://doi.org/10.1017/thg.2012.126

Loechner, J., Sfärlea, A., Starman, K., Oort F., Thomsen, L. A., Schulte-Körne, G., & Platt, B. (2020). Risk of depression in the offspring of parents with depression: The role of emotion regulation, cognitive style, parenting and life events. *Child Psychiatry and Human Development, 51*, 294–309. https://doi.org/10.1007/s10578-019-00930-4

Lombardo, K. L., & Motta, R. W. (2008). Secondary trauma in children of parents with mental illness. *Traumatology, 14*(3), 57–67. https://doi.org/10.1177/1534765608320331

Lovejoy, M. C., Graczyk, P. A., O'Hare, E., & Neuman, G. (2000). Maternal depression and parenting behavior: A meta-analytic review. *Clinical Psychology Review, 20*(5), 561–592. https://doi.org/10.1016/S0272-7358(98)00100-7

McAdams, T. A., Rijsdijk, F. V., Neiderhiser, J. M., Narusyte, J., Shaw, D. S., Natsuaki, M. N., Spotts, E. L., Ganiban, J. M., Reiss, D., Leve, L. D., Lichtenstein, P., & Eley, T. C. (2015). The relationship between parental depressive symptoms and offspring psychopathology: Evidence from a children-of-twins study and an adoption study. *Psychological Medicine, 45*(12), 2583–2594. https://doi.org/10.1017/S0033291715000501

McCarty, C. A., Zimmerman, F. J., Digiuseppe, D. L., & Christakis, D. A. (2005). Parental emotional support and subsequent internalizing and externalizing problems among children. *Journal of Developmental and Behavioral Pediatrics*, *26*(4), 267–275.

McLaughlin, K. A., Behar, E., & Borkovec, T. (2008). Family history of psychological problems in generalized anxiety disorder. *Journal of Clinical Psychology, 64*, 905–918. https://doi.org/10.1002/jclp.20497

McLaughlin, K. A., Greif Green, J., Gruber, M. J., Sampson, N. A., Zaslavsky, A. M., & Kessler, R. C. (2012). Childhood adversities and first onset of psychiatric disorders in a national sample of US adolescents. *Archives of general psychiatry*, *69*(11), 1151–1160. https://doi.org/10.1001/archgenpsychiatry.2011.2277

Meadows, S. O., McLanahan, S. S., & Brooks-Gunn, J. (2007). Parental depression and anxiety and early childhood behavior problems across family types. *Journal of Marriage and Family, 69,* 1162-1177. https://doi.org/10.1111/j.1741-3737.2007.00439.x

Miloyan, B., Joseph Bienvenu, O., Brilot, B., & Eaton, W. W. (2018). Adverse life events and the onset of anxiety disorders. *Psychiatry research*, *259*, 488–492. https://doi.org/10.1016/j.psychres.2017.11.027

Mineka, S., Watson, D., & Clark, L. A. (1998). Comorbidity of anxiety and unipolar mood disorders. *Annual Review of Psychology, 49*, 377–412. 10.1146/annurev.psych.49.1.377

Nanni, V., Uher, R., & Danese A. (2012). Childhood maltreatment predicts unfavorable course of illness and treatment outcome in depression: A meta-analysis. *American Journal of Psychiatry*, *169*(2), 141–151. https://doi.org/10.1176/appi.ajp.2011.11020335.

Natsuaki, M. N., Neiderhiser, J. M., Harold, G. T., Shaw, D. S., Reiss, D., & Leve, L. D. (2019). Siblings reared apart: A sibling comparison study on rearing environment differences. *Developmental Psychology, 55*, 1182–1190. https://doi.org/10.1037/dev0000710.

Natsuaki, M. N., Shaw, D. S., Neiderhiser, J. M., Ganiban, J. M., Harold, G. T., Reiss, D., & Leve, L. D. (2014). Raised by depressed parents: Is it an environmental risk? *Clinical Child and Family Psychology Review*, *17*(4), 357–367. https://doi.org/10.1007/s10567-014-0169-z

Plomin, R. (2014). Genotype-environment correlation in the era of DNA. *Behavior genetics*, *44*(6), 629–638. https://doi.org/10.1007/s10519-014-9673-7

Radloff, L. S. (1977). The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, *1*(3), 385–401. https://doi.org/10.1177/014662167700100306

Scarr, S., & McCartney, K. (1983). How people make their own environments: A theory of genotype → environment effects. *Child Development*, *54*(2), 424–435.

Schmidt, C. W. (2007). Environmental connections: A deeper look into mental illness. *Environmental health perspectives, 115*(8), A404–A410. https://doi.org/10.1289/ehp.115-a404

Schmitz, S., Cherny, S. S., Fulker, D. W., & Mrazek, D. A. (1994). Genetic and environmental influences on early childhood behavior. *Behavior Genetics, 24*, 25–34. https://doi.org/10.1007/BF01067926

Singh, A. L., D'Onofrio, B. M., Slutske, W. S., Turkheimer, E., Emery, R. E., Harden, K. P., Heath, A. C., Madden, P. A., Statham, D. J., & Martin, N. G. (2011). Parental depression and offspring psychopathology: A children of twins study. *Psychological medicine, 41*(7), 1385–1395. https://doi.org/10.1017/S0033291710002059

Spielberger, C. D., Gorsuch, R. L., Lushene, R., Vagg, P. R., & Jacobs, G. A. (1983). *Manual for the State-Trait Anxiety Inventory*. Palo Alto, CA: Consulting Psychologists Press.

Sullivan, P. F., Neale, M. C., & Kendler, K. S. (2000). Genetic epidemiology of major depression: Review and meta-analysis. *American Journal of Psychiatry, 157*(10), 1552–1562. https://doi.org/10.1176/appi.ajp.157.10.1552

Thapar, A., & McGuffin, P. (1997). Anxiety and depressive symptoms in childhood—A genetic study of comorbidity. *Journal of Child Psychology and Psychiatry, 38*, 651–656. https://doi.org/10.1111/j.1469-7610.1997.tb01692.x

Tully, E. C., Iacono, W. G., & McGue, M. (2008). An adoption study of parental depression as an environmental liability for adolescent depression and childhood disruptive disorders. *American Journal of Psychiatry, 165*(9), 1148–1154. https://doi.org/10.1176/appi.ajp.2008.07091438

van der Sluis, C. M., van Steensel, F. J. A., & Bögels, S. M. (2015). Parenting and children's internalizing symptoms: How important are parents? *Journal of Child and Family Studies 24*, 3652–3661. https://doi.org/10.1007/s10826-015-0174-y

Waxler, E., Thelen, K., & Muzik, M. (2011). Maternal perinatal depression—Impact on infant and child development. *European Psychiatric Review, 4*(1), 41–47

Weinberger, A., Gbedemah, M., Martinez, A., Nash, D., Galea, S., & Goodwin, R. (2018). Trends in depression prevalence in the USA from 2005 to 2015: Widening disparities in vulnerable groups. *Psychological Medicine, 48*(8), 1308–1315. https://doi.org/10.1017/S0033291717002781

Weissman, M. M., Wickramaratne, P., Nomura, Y., Warner, V., Pilowsky, D., & Verdeli, H. (2006). Offspring of depressed parents: 20 years later. *American Journal of Psychiatry. 163*(6), 1001–1008. https://doi.org/10.1176/ajp.2006.163.6.1001

Yoshikawa, H., Aber, J. L., & Beardslee, W. R. (2012). The effects of poverty on the mental, emotional, and behavioral health of children and youth: Implications for prevention. *American Psychologist, 67*(4), 272–284. https://doi.org/10.1037/a0028015

Zhu, Y., Chen, X., Zhao, H., Chen, M., Tian, Y., Liu, C., Han, Z. R., Lin, X., Qiu, J., Xue, G., Shu, H., & Qin, S. (2019). Socioeconomic status disparities affect children's anxiety and stress-sensitive cortisol awakening response through parental anxiety. *Psychoneuroendocrinology, 103*, 96–103. https://doi.org/10.1016/j.psyneuen.2019.01.008