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Etiological Contributions to the Covariation Between Children's Perceptions of Inter-parental Conflict and Child Behavioral Problems

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Abstract

Prior work has suggested that inter-parental conflict likely plays an etiological role in child behavior problems. However, family-level measurement of inter-parental conflict in most traditional child twin studies has made it difficult to tease apart the specific causal mechanisms underlying this association. The Children's Perception of Inter-parental Conflict scale (CPIC) provides a child-specific measurement tool for examining these questions, as its subscales tap multiple dimensions of conflict assessed from the child's (rather than the parent's) perspective. The current study examined (1) the degree of genetic and environmental influence on each of the CPIC subscales, and (2) etiological contributions to the covariation between the CPIC scales and parental reports of child behavioral problems. The CPIC was completed by 1,200 child twins (aged 6-11 years) from the Michigan State University Twin Registry (MSUTR). Parents completed the Child Behavior Checklist (CBCL) to assess child internalizing and externalizing behavior problems. Multivariate models were examined to evaluate the relative contributions of genetic and environmental factors to both the CPIC scales and to their overlap with child behavioral outcomes. Modeling results indicated no significant moderation of sex or age. Significant environmental overlap emerged between the CPIC conflict properties scale and child internalizing and externalizing problems. By contrast, significant genetic correlations emerged between the CPIC self-blame scale and externalizing problems as well as between the CPIC threat scale and internalizing problems. Overall, findings suggest that the subscales of the CPIC are somewhat etiologically diverse and may provide a useful tool for future investigations of possible gene-environment interplay.

Keywords

inter-parental conflict; genetic; environment; twins; child behavior problems; etiology

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The association between inter-parental conflict and child emotional and behavioral adjustment is a robust one. In general, findings have indicated a positive relationship between high levels of inter-parental conflict behavioral and emotional problems in children (Cummings & Davies, 1994, 2002; Grych & Fincham, 1990; Rhoades, 2008). Longitudinal studies have further suggested that inter-parental conflict may play a causal role in child behavior problems (Davies, Harold, Goeke-Morey, & Cummings, 2002; Grych, Harold, & Myles, 2003; Harold & Conger, 1997), such that improvements in child behavior are observed following the dissolution of high-conflict marriages, whereas children whose

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parents remain in high-conflict relationships demonstrate poorer outcomes (Amato & Booth, 1996; Booth & Amato, 2001; Morrison & Coiro, 1999). This conclusion has been further bolstered by couples' intervention research demonstrating associations between improvements in the marital/parental relationship and subsequent reductions in child behavior problems (Schulz, Cowan, & Cowan, 2006).

By contrast, recent behavioral genetic studies have demonstrated that genetic influences at least partially mediate the association between inter-parental conflict and child behavior problems, suggesting potential gene-environment interplay (Feinberg, Reiss, Neiderhiser, & Hetherington, 2005; Harden et al., 2007; Horwitz et al., 2010; Neiderhiser et al., 1999). This interplay likely involves a combination of (1) gene-environment correlations, defined as non-random or genetically influenced exposure to particular environmental experiences, and (2) gene x environment interactions, defined as genetically-modulated individual differences in sensitivity to environmental risk factors. That is, exposure to inter-parental conflict may itself be non-random, and its impact on child behavior problems may be mediated or moderated by genetic effects operating with the family. Should gene-environment correlations partially account for the relationship between inter-parental conflict and child behavior problems, significant genetic correlations (r_a) between inter-parental conflict and child behavior would emerge within behavior genetic studies. Significant shared and non-shared environmental correlations, however, would highlight a potentially important role for inter-parental conflict in the etiologic moderation of child behavior. However, the utility of genetically-informed studies, particularly twin methodology, in deciphering the extent to which these relationship are due to gene-environment correlations and interactions has been limited by the methods used to assess inter-parental conflict.

Past work has typically relied on parental reports of their own marital conflict, marital or marital satisfaction (Neiderhiser et al., 1999; Feinberg et al., 2005), or on observational reports of interaction quality between parents (Ganiban et al., 2009). While generally informative and reliable, these family-level measures are necessarily identical across all siblings in a given family. It is therefore impossible to partition them into their genetic and environmental components within traditional child-based twin/sibling designs, a limitation that extends to examinations of gene-environment correlations (since such analyses are predicated on the comparison of varying degrees of sibling similarity across levels of genetic relatedness). Because the child-based twin/sibling design is by far the most common behavioral genetic design, this methodological challenge has had the unfortunate effect of serving to stymie research into the etiological links between inter-parental conflict and child outcome.

More recent work has sought to circumvent this logistic difficulty. The Children-of-Twins design, for example, assesses adult twins (with their own families), and thus obtains *individual-level* report of marital relationships. Research using this more recent design has demonstrated that the relationship between family factors, including marital quality and child adjustment appears to be, in part, genetically-mediated (Schermerhorn et al., 2011). These findings offer further support of shared etiological processes (i.e., potential gene-environment correlations). Nevertheless, Children-of-Twins designs are as yet relatively rare, and moreover, have the disadvantage that each twin has a different spouse, complicating causal inferences from their results (D'Onofrio et al., 2003).

Twin-specific ratings of inter-parental conflict in the traditional child-base twin/sibling design represent another, perhaps more compelling strategy for circumventing the problem of family-level measurements of inter-parental conflict. The advantages to this latter approach are in part practical: as alluded to above, twin/sibling designs are quite common, and moreover, allow researchers to control for the actual characteristics of the parents (since all full siblings have the same parents). Perhaps more importantly, however, youth reports of inter-parental conflict are in fact *more* predictive of the child's behavior problems than are parent reports of marital conflict (Cummings & Davies, 2002; Cummings, Davies, & Simpson, 1994; Grych & Fincham, 1990; Grych, Seid, & Fincham, 1992). Theoretical and empirical work has further shown that the specific topics of marital disputes are differentially related to children's reactions and behaviors, such that *conflicts about the child* are linked to greater behavioral dysregulation compared to topics that are unrelated to the child (Cummings & Davies, 2002; Cummings, Goeke-Morey, & Papp, 2004; Harold, Fincham, Osborne, & Conger, 1997).

Despite these advantages however, we know of only one genetically-informed study that has utilized a child report of inter-parental conflict. Using a Children-of-Twins design, Harden et al., (2007) found that the genetic components of inter-parental conflict accounted for approximately 20% of the total variance in their children's conduct problems, suggesting that gene-environment correlations may partially account for the relationship between inter-parental conflict and child behavior problems. Although such work is clearly important, the measure of inter-parental conflict used in Harden et al. (2007) consisted of two questions rated on a 4-point Likert scale: one related to frequency and one related to intensity of conflict. Measurement of inter-parental conflict in this way is unlikely to be particularly reliable and, as acknowledged by Harden et al. (2007), may not be capturing all the relevant domains of inter-parental conflict (Grych, Seid, & Fincham, 1992).

The Children's Perception of Inter-parental Conflict Scale

The Children's Perception of Inter-parental Conflict scale (CPIC) has been an important method for quantifying multiple dimensions of youth perception and appraisals of the disputes of their parents' (Grych, Seid, & Fincham, 1992). The CPIC was born out of the recognition that the child's perceptions and appraisals of inter-parental conflict often play a critical determining role as to its impact on youth behavior problems (Grych & Fincham, 1990). Four subscales reflecting differential aspects of conflict have been identified in prior factor-analytic work (Nigg et al., 2009): conflict properties (i.e., conflict frequency and intensity), triangulation/stability (i.e., enduring aspects of conflict as well as the degree to which children feel caught between parents), self-blame (i.e., the extent to which children blame themselves for inter-parental conflict), and perceived threat regarding potential negative consequences of inter-parental conflict, such as divorce.

Because the CPIC is inherently an individual-level measure (i.e., it is completed separately by each twin), it should be a useful tool for further examination of the origins of the relationship between inter-parental conflict and child behavioral and emotional problems. Evidence of differential etiological associations among these various dimensions of conflict, for example, would help clarify the processes by which exposure to conflict, and appraisals of that conflict, are related. Examination of the etiological relationships between these dimensions of conflict and child behavior problems would then illuminate *how* inter-parental conflict influences the development of child behavioral and emotional problems. Such results should serve to confirm or refute the presence of gene-environment correlations in the development of youth behavior and emotional problems, and in doing so, should facilitate the subsequent development of targeted intervention strategies. The purpose of the current study was to do just this, examining both the degree to which genetic and environmental factors influence each of the CPIC scales as well as the origins of their overlap with child behavioral and emotional problems.

METHOD

Participants

Participants were child twin pairs assessed as part of the Michigan State University Twin Registry (MSUTR), an ongoing project examining genetic and environmental contributions to both internalizing and externalizing psychopathology (Klump & Burt, 2006). Families were recruited via State of Michigan birth records in collaboration with the Michigan Department of Community Health (MDCH). The MDCH manages birth records and can identify all twins born in Michigan. Birth records are confidential in Michigan; thus, the following recruitment procedures were designed to ensure anonymity of families until they indicate an interest in participating. Once twins were identified, MDCH then made use of the Michigan Bureau of Integration, Information, and Planning Services database to locate current addresses through parent drivers' license information. MDCH then mailed pre-made recruitment packets to parents. A reply postcard was included for parents to indicate their interest in participating. Interested families were then contacted directly by project staff. Parents who did not respond to the first mailing were sent additional mailings approximately one month apart until either a reply was received or up to four letters had been mailed. The final letter is sent via certified mail, a highly effective way of reaching non-responding families. Thus far, we have received reply postcards from 62% of recruited families (as recruitment is still on-going, final response rate data is not yet available). This response rate is on par with, or better than, those of other twin registries that use similar types of anonymous recruitment mailings (Baker, Barton, & Raine, 2002; Hay, McStephen, Levy, & Pearsall-Jones, 2002). Participating families endorsed ethnic group memberships at rates comparable to other area inhabitants (e.g., Caucasian: 85.5% and 85.5%, African-American: 5.7% and 6.3% for the participating families and the local census, respectively). Parental education was generally representative of the families with children living in the surrounding area: partial high school (1.5%), high school graduate (7.8%), high school and trade school education (3.4%), some college (22.2%), Associate's degree (11.9%), Bachelor's degree (33.3%), Master's degree (17.4%), and advanced degree (2 or more years of graduate school, 2.5%). Similarly, 14.3% of families in our sample lived below federal poverty guidelines versus 14.8% for the state of Michigan more generally. Our recruitment strategy thus appears to yield a sample that is broadly representative of the area population. For a full description of recruitment procedures for the MSUTR, see Klump and Burt (2006).

The current sample consisted of 600 child monozygotic (MZ) and dizygotic (DZ) child twin pairs (total n = 1,200 twins) participating in the Twin Study of Behavioral and Emotional Development in Children (TBED-C), one study embedded within the MSUTR. Of these, 475 pairs participated in the funded project, with the remaining 125 pairs serving as pilot data for the funded project. The current sample was composed of 294 MZ twin pairs (49.0% female) and 306 DZ twin pairs (47.1% female). Twins ranged in age from 6-10 years, although a few had turned 11 by the time they completed their assessment (*M*=8.3, *SD*=1.4 years). Mothers ranged in age from 26-59 years (*M*=39.4, *SD*=5.3 years). Parents gave informed consent for both themselves and their children and children provided informed assent. All research protocol was approved by the Michigan State University Institutional Review Board.

In terms of family constellation, 82.3% of twin pairs (n=494 pairs or 988 twins) were living in two-parent households whereas 16.7% of twin pairs (n=106 pairs or 212 twins) were living with just one parent. Of those living in two-parent households, 78.5% were living with married biological parents, 6.5% were living with partnered (non-married) biological parents, and 15.0% were living with one biological parent and one step-parent. For children living in one-parent households, biological parents were either divorced (63.2%), separated (19.2%), or were re-partnered (16.9%).

Perceptions of Marital Conflict

Youth perceptions and appraisals of inter-parental conflict were assessed with the CPIC (Grych, Seid, & Fincham, 1992). Each twin completed a separate CPIC during the computerized assessment at the MSU laboratory. The 48 CPIC items were rated by participating twins on a three-point scale (1-3: true, sort of true, and false). Children rated their biological parents or primary residential parents, depending on their family composition. Youth with no contact with a second parent did not complete the CPIC. While the CPIC was originally constructed using samples of children ages 9-11 years, additional work regarding construct validity has extended its use to younger samples (McDonald & Grych, 2006; Nigg et al., 2009). In addition, the questionnaire was read to twins with reading levels under 5th grade (as assessed via a brief reading screen; Torgesen, Wagner, & Rashotte, 1999) to assure comprehension of the items. Based on exploratory and confirmatory analysis of the 48 items (Nigg et al., 2009), four empirically derived CPIC scale scores were computed. These scales included conflict properties, triangulation/stability, self-blame, and threat (as described below).

Items loading on the conflict properties scale (n=11 items, α = .88) assessed the perceived frequency and intensity of the observed conflict. Sample items from this scale include “My parents get really mad when they argue” and “My parents hardly ever argue.” The triangulation/stability scale (n=13 items, α = .89) required children to report on the extent to which they feel caught in the middle of conflict as well as whether or not their parents’ conflict is an entrenched and enduring part of family life. Representative items from this scale include “I feel like I have to take sides when my parents argue” and “Even after my parents argue, they stay mad at each other.” The self-blame and threat scales assessed cognitive appraisals regarding inter-parental conflict. Items on the self-blame scale (n=9 items, α = .85) assessed the extent to which children blame themselves for the conflict they have observed between their parents. Sample items from the CPIC self-blame scale include “It is usually my fault when my parents argue”; and “I am to blame when my parents argue.” Items loading on the threat scale (n=6 items, α = .83) assessed youth perceptions regarding the negative implications their parents’ marital conflict may have for them. Sample items on this scale include “When my parents argue, I worry about what will happen to me” and “I get scared when my parents argue.” As reports of triangulation/stability and threat varied by family composition (e.g., whether parents were married, separated/divorced, or re-partnered, p=.026), family composition was regressed out of the CPIC scales prior to model fitting.

Child Behavioral Problems

Parents of twins (in most cases, the mother) completed the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001) for each twin to assess youth behavioral problems. The CBCL is a widely-used, empirically-derived, broadband behavioral rating scale that has demonstrated excellent psychometric properties and clinical predictive validity (Achenbach & Rescorla, 2001). The raw scores on the composite internalizing and externalizing behavior scales were retained for analyses. Both scales demonstrated adequate internal consistency (internalizing α=.90; externalizing α=.89).

Zygosity Determination

Zygosity was established using physical similarity questionnaires administered to the twins’ primary caregiver (Peeters, Van Gestel, Vlietinck, Derom, & Derom, 1998). On average, the physical similarity questionnaires used by the MSUTR have accuracy rates of 95% or better when compared to other methods such as blood-typing.

Data Analysis

Twin methodology makes use of the difference in the proportion of genes shared between monozygotic (MZ) and dizygotic (DZ) twin pairs to estimate genetic and environmental contributions to observed behaviors. Identical (monozygotic) twins share 100% of their segregating genes, whereas fraternal (dizygotic) twins share 50% on average. Utilizing these differences, the variance within observed behaviors is partitioned into three components: additive genetic (a^2), shared environmental (c^2), and non-shared environmental plus measurement error (e^2). The additive genetic component is the effect of individual genes summed over loci. Additive genetic effects, if acting alone, would result in MZ correlations that are double DZ correlations. The shared environment is that part of the environment common to siblings that acts to make them similar to each other. Shared environmental effects do not vary by zygosity, and if acting alone, would result in approximately equal MZ and DZ correlations. The non-shared environment encompasses environmental factors differentiating twins within a pair, as well as measurement error. The non-shared environment does not also differ by zygosity and serves to reduce MZ and DZ correlations to the same degree (as does measurement error). Importantly, twin methodology is also dependent on the *equal environments assumption*, which assumes that MZ twins are no more likely to share etiologically-relevant environmental influences than are DZ twins. Under this assumption, differences in the MZ and DZ correlations are due to differences in their genetic similarity.

Phenotypic correlations for MZ and DZ twins were first examined in order to preliminarily gauge the relative genetic and environmental influences on each of the scales as well as on their overlap. A series of univariate models were then conducted in order to specify the degree to which genetic, shared, and non-shared environmental influences contributed to the CPIC scales as well as to the CBCL measures of internalizing and externalizing behaviors. Following these analyses, multivariate models were fit to covariance matrices in order to examine the structural relationships between (1) the CPIC scales and internalizing behaviors, and (2) between the CPIC scales and externalizing behaviors. We specifically fitted a correlated factors model (see Figure 1, Neale & Cardon, 1992), which parses the phenotypic variance of each scale and the phenotypic covariances between pairs of scales into their respective genetic, shared, and non-shared environmental components. Of specific importance for the current analyses, the genetic, shared, and non-shared environmental covariances between scales are standardized on their respective variances to produce genetic, shared environmental, and non-shared environmental correlations (i.e., r_a, r_c, r_e). These statistics reveal the extent to which a specific effect (e.g., the shared environmental effect) on one variable is correlated with the same effect on another variable. Significant genetic correlations (r_a) between measures of inter-parental conflict and child behavior problems are specifically indicative of potential gene-environment correlation effects (rGE).

Model fitting was conducted in Mx (Neale, Boker, Xie, & Maes, 2003) on the raw data using full-information maximum likelihood techniques (FIML). FIML raw data techniques produce less biased and more consistent estimates than do other techniques that manage missing data, such as pairwise or list-wise deletion (Little & Rubin, 1987). FIML assumes that the data are missing at random and are thus ignorable. Missing data was generally low for this sample (i.e., less than 5.8%). Missingness (data coded as present versus absent for the CPIC self-blame scores) was unrelated to family constellation, age of twins, age of mother, parental education, or parental income (all *p*s>.39).

When fitting models to raw data, variances, covariances, and means of those data were first freely estimated by minimizing minus twice the log-likelihood (−2lnL). The minimized value of −2lnL in the baseline is compared with the −2lnL obtained in more restrictive moderator correlated factors model to yield a likelihood-ratio χ^2 test. The chi-square was then converted to the Akaike's Information Criterion (AIC; Akaike, 1974) and the Bayesian Information Criterion (BIC) so as to measure model fit relative to parsimony, with lower or more negative values indicating a better fit (Markon & Krueger, 2004). Root mean square error of approximation (RMSEA) was also used to evaluate absolute model fit. RMSEA values less than .05 denote acceptable fit, with smaller values indicating better model fit.

In order to directly examine any potential moderating effects of sex, we fitted models in which all parameter estimates in the correlated factors model were allowed to vary by sex (i.e., sex-differences model), and then also constrained these parameter estimates to be equal across sex (i.e., no sex-differences model). In order to similarly examine the potential moderating effects of age, we also fitted models in which parameter estimates were allowed to vary by age (e.g., ages 6-8 versus ages 9-11) as well as models constraining estimates to be equal for all twins regardless of age (age-differences versus no age-differences models). Should effects vary significantly by sex or by age, constraining parameters to be equal across these moderators in the no sex-differences and no age-differences models would result in a decrement in model fit, as indexed by larger AIC and BIC values.

RESULTS

Descriptive Statistics

Table 1 presents the means and standard deviations of the four CPIC scales and the two CBCL scales, separately across twin sex and zygosity. There were no significant differences in any of the scale scores by zygosity. Sex differences in CPIC scale scores were also non-significant with the exception of the self-blame scale. Boys reported higher mean levels of self-blame than did girls (p<.001, Cohen's d=.34). Additionally and as expected, mean externalizing scores were higher for boys than girls (p=<.001, Cohen's d=.39). Mean internalizing scores were higher boys than for girls, but the difference was not statistically significant (p=.16). In all, 17.5% of the twins (n=211) had internalizing scores in the borderline to clinically-significant range, while 14.8% of the twins (n=177) had externalizing scores in the borderline to clinically-significant range.

Age was significantly correlated with triangulation/stability (r = −.18, p<.01) and self-blame (r = −.15, p<.01), such that younger children tended to report higher levels of each subscale. Age was also significantly correlated with externalizing problems (r = −.09, p<.05). Age was not significantly correlated to any of the other scales (all ps>.12).

Correlations

Intraclass correlations were calculated using the double-entry method separately for MZ and DZ twins. The double entry method retains data from both twins so as to remove any variance associated with the arbitrary ordering of twins within each pair. Results are presented in Table 2. As seen there, MZ and DZ correlations for the conflict properties scale were similar in magnitude, suggesting that etiological contributions to this scale were primarily shared environmental in origin. For the other three CPIC scales, however, the MZ correlations were significantly larger than the DZ correlations, signaling the probable presence of genetic influences on those scales. As expected based on prior literature (Burt, 2009), MZ correlations were significantly larger for both internalizing and externalizing problems, pointing toward significant genetic influences on measures of child emotional and behavioral symptoms.

Scale-specific relations also emerged between the CPIC scales and the measures of child outcome. Internalizing problems were significantly correlated with two of the four CPIC scales (i.e., triangulation/stability and threat). By contrast, externalizing problems were related to all of the CPIC scales with the exception of threat. In short, the CPIC scales appear to differentially predict the two broad domains of child psychopathology.

Cross-twin cross-trait correlations further revealed some differences between the scales. Moderate MZ and DZ correlations were observed between conflict properties and triangulation-stability as well as between conflict properties and externalizing problems, suggesting that shared environmental factors may be contributing to their respective relationships. By contrast, cross-twin, cross-trait correlations between threat and internalizing problems, threat and triangulation-stability, and self-blame and externalizing problems, were larger for MZ twins than for DZ twins, suggesting that genetic factors may be influencing their overlap. In all, the intraclass and cross-twin cross-trait correlations tended to indicate potential etiological differences among the four CPIC scales as well as among their covariations with internalizing and externalizing problems.

Univariate Results

Prior to the multivariate models, univariate models were fitted to the data. Results are presented in Table 3. Both internalizing and externalizing behavior problems were attributable to moderate genetic and non-shared environmental influences, with smaller but still significant contributions from the shared environment. For its part, conflict properties was predominately influenced by shared environmental factors (51% of the variance), although non-shared environmental influences also contributed. Triangulation/stability was also heavily influenced by shared and non-shared environmental factors, although genetic influences did make a small but significant contribution. Both self-blame and threat, by contrast, evidenced particularly large non-shared environmental influences, and small (in the case of threat) to moderate (in the case of self-blame) genetic influences. Threat was modestly influenced by shared environmental influences as well. As evidenced by their non-overlapping confidence intervals, shared environmental influences were significantly larger for conflict properties as compared to self-blame and threat. Non-shared environmental influences, by contrast, were larger for youth reports of self-blame and threat relative to conflict properties. Genetic influences did not appear to vary significantly across the four scales.

Multivariate Models

CPIC Sales, Internalizing, and Externalizing Problems—Correlated factors models were next fiitted to both (1) the CPIC scales and child internalizing behaviors and (2) the CPIC scales and child externalizing behaviors. In both cases, sex-difference (males versus females) and no sex-difference models as well as age-difference (6-8 year olds versus 9-11 year olds) and no age-difference models were fitted to the data. Model fit statistics are presented in Table 4. As can be seen by the lower AIC and BIC values, constraining parameter estimates to be equal across sex and age did not result in a significant decrement in model fit. Further likelihood ratio tests indicated that constraining parameter estimates to be equal across sex and age did not result in a significant detriment in model fit (all *p*s>.34). The etiological relationships between the CPIC and CBCL scales thus appear to be, in large part, similar for males and females and across the age range of the sample. Given this, the correlated factors models assuming no differences in parameter estimates across age and sex were examined hereafter.

Genetic and environmental correlations amongst the four CPIC scales are presented in Table 5. In general, the inter-relationships among the CPIC scales appear to be largely in line with past work regarding both the theoretical and psychometric properties of the measure (Grych & Fincham, 1990; Nigg et al., 2009). First, only environmental correlations involving the conflict properties scale were significant (i.e., the large shared environmental correlation with triangulation-stability, and the small non-shared environment correlations with triangulation-stability and threat). Genetic influences on conflict properties did not meaningfully overlap with those on the other three scales, likely reflecting the fact that genetic influences on this scale were quite small in magnitude (i.e., 2%). The threat scale evidenced small-to-moderate but significant non-shared environmental overlap with all three of the other CPIC scales. Additionally, there was moderate genetic overlap between the triangulation-stability scale and both cognitive appraisal scales (i.e., self-blame and threat). The other shared and non-shared environmental correlations were not significantly larger than zero. Of note, the non-shared environmental influences on the self-blame scale (which accounted for 65% of the total variance in that scale) were largely unique to that scale.

Genetic and environmental correlations between the CPIC and CBCL scales are presented in Table 6. As can be seen there, differential relationships emerged between the CPIC scales and child internalizing and externalizing behaviors. Triangulation-stability evidenced moderate genetic and shared environmental overlap with both internalizing and externalizing behaviors. Correlations involving the conflict properties scale, by contrast, were exclusively environmental in origin. These included modest non-shared environmental correlations between conflict properties and both internalizing and externalizing behaviors. More interestingly, however, a large shared environmental correlation was observed between conflict properties and externalizing behaviors, but not between conflict properties and internalizing. Put differently, twins who reported similarly high levels of conflict properties were also rated as having similarly high levels of externalizing behaviors, regardless of zygosity.

Self-blame and threat showed very different patterns of association, in that there appeared to be specific relationships between threat and internalizing problems and between self-blame and externalizing problems. The non-shared environmental correlation between threat and internalizing behaviors was significant and notably large, suggesting that within identical twin pairs, the twin reporting higher levels of perceived threat in relation to inter-parental conflict also evidenced higher internalizing behaviors. Specific and significant genetic correlations emerged between the threat scale and internalizing problems as well as between self-blame and externalizing problems.

DISCUSSION

Assessment of inter-parental conflict from the child’s perspective may be advantageous for both theoretical and psychometric reasons. Developmental and family work has advocated for assessing inter-parental conflict from the child’s perspective as these appraisals better predict child behavior (Grych & Fincham, 1990). From a measurement standpoint, using individual twin report of inter-parental conflict within a traditional child twin design also allows for more legitimate identification of shared and non-shared environmentally-mediated influences of inter-parental conflict on child outcome (Turkheimer, D’Onofrio, Maes, & Eaves, 2005), as well as more in-depth investigation of possible gene-environment correlation processes. Because each twin reports on their own perceptions of their parents’ conflict, variance across these dimensions can be parsed into their respective genetic and environmental components. The goals of the current study were thus two-fold: (1) examine the genetic and environmental contributions to the various components of inter-parental conflict, as measured from the child’s perspective, and (2) clarify the origins of overlap between the CPIC scales and youth internalizing and externalizing problems.

Analyses revealed considerable etiological differences among the CPIC scales. The conflict properties subscale, which reflects youth perceptions of the frequency and intensity of inter-parental conflict, was found to be almost exclusively environmental in origin. Indeed, univariate estimates indicated that this measure was predominately influenced by shared environmental factors, with moderate contributions from the non-shared environment and negligible genetic factors. The triangulation/stability subscale was also largely a function of environmental influences, although genetic influences also contributed. In contrast, the self-blame and threat subscales were primarily influenced by non-shared environmental factors (65% and 69% of the variance respectively). Both scales were also influenced by genetic factors.

Importantly, these differences in the degree and type of etiological influence on the various CPIC scales generally map onto differences in the theoretical and empirical relationships among the scales. The conflict properties subscale is thought to reflect largely observable and objective elements of inter-parental conflict (Grych, Seid, & Fincham, 1992). The presence of moderate-to-large shared environmental influences thus likely reflects the fact that because twins necessarily share the same parents, they are also typically observing the same frequency and intensity of inter-parental conflict. The triangulation/stability scale is also thought to reflect some of the more objective aspects of inter-parental conflict (e.g., my parents stay mad even after they argue), while also reflecting each child's experience of the arguments (e.g., I feel like I have to take sides when my parents argue). As the latter likely reflects temperamental differences, which are themselves heritable (Goldsmith, Buss, & Lemery, 1997; Isen, Baker, Raine, & Bezdijan, 2009), the presence of genetic influences on this scale is perhaps not surprising.

By contrast, the self-blame and threat subscales have been specifically hypothesized to reflect more subjective appraisals regarding the meaning of inter-parental conflict (Grych & Fincham, 1990; Grych, Seid, & Fincham, 1992; Nigg et al., 2009). These subjective appraisals of self-blame and threat have been argued to be the proximal means by which inter-parental conflict influences child behavior (Grych & Fincham, 1990; Grych, Fincham Jouriles, & McDonald, 2000; Grych, Harold, & Miles, 2003). Consistent with this, the large contributions of non-shared environmental factors to both the self-blame and threat scales supports the notion that both scales are indeed tapping into the unique interpretations of each twin.

Building on the above point, we would argue that twin discrepancies on the CPIC scales may well be capturing differences in *perceptions* or *appraisals* of conflict, rather than differences between twins in exposure to conflict. This appeared to be particularly the case for the self-blame and threat scales, consistent with the notion that self-blame and threat should partially reflect aspects of twin temperament and/or constitutional factors. In contrast, shared environmental effects accounted for the largest proportion of the variance in the conflict properties scale, indicating that this scale likely reflect more objective aspects of inter-parental conflict (as agreement between twins in regard to frequency and intensity of conflict was much higher for these scales relative to the appraisal scales of self-blame and threat). The CPIC may therefore be an especially useful tool for determining whether these different dimensions of conflict (e.g., exposure factors versus child appraisals) account for shared and non-shared environmental contributions to the variance in child behavioral outcomes and/or are reflective of gene-environment correlations in children's responses to their parent's conflict.

In line with this possibility, unique patterns of etiological overlap between the different CPIC scales and reports of child internalizing and externalizing problems did in fact emerge herein. Genetic influences on internalizing and externalizing problems respectively overlapped with those on the threat and self-blame, the two cognitive appraisal scales. Genetic contributions to triangulation/stability overlapped with those for both internalizing and externalizing problems. As alluded to above, these patterns of genetic overlap may reflect the common role of temperament as a contributor to these processes. Alternately, this genetic overlap could also reflect the possibility that negative appraisals of one's experiences may in fact be a genetic marker for the development of psychopathology (e.g., Kendler et al., 2010).

The significant non-shared environmental correlation between threat and internalizing problems indicate that appraisals of threat account for a significant proportion of the non-shared environmental variation in internalizing problems. Similarly, conflict properties (i.e., frequency and severity) and triangulation/stability each accounted for a significant proportion of the shared environmental influences of externalizing problems. As evidenced here, the CPIC may be of particular use for unpacking environmental influences on child outcome within a classical child twin study. Furthermore, as both of these scales evidenced prominent shared and non-shared environmental influences (and small, if any, genetic influence), both conflict properties and triangulation/stability may prove to be useful for examinations of gene x environment interaction processes (rather than gene-environment correlation processes) that contribute to child psychopathology.

Implications

Distinguishing aspects of conflict that operate via shared versus non-shared environmental mechanisms is likely important for future work examining the etiology of child behavior problems. For example, the conflict properties subscale, which emerged as largely influenced by shared environmental factors, may be a target measure for quantifying potential shared environmental main effects on child behavioral outcomes (see Burt, 2009). Indeed, significant overlap emerged between shared environmental influences on externalizing behaviors and those contributing to the severity and intensity of marital conflict in the present study. One interpretation of these findings is that objective aspects of conflict (e.g., frequency and intensity) may environmentally shape the presence or development of externalizing behavior problems, and do so in ways that are similar for all children within a family. Interventions targeting inter-parental conflict frequency and intensity would thus be expected to assist in reducing externalizing behaviors for all siblings in the family, as has been found in prior work (for example, see Wolchik et al., 2002).

Similarly, because the self-blame and threat scales were predominately influenced by non-shared environmental factors, these subscales may be ideal for examining child-specific effects of conflict. In particular, these sorts of negative appraisals of conflict could serve as specific targets for cognitive inter-parental conflict. Put differently, although it may be the case that efforts to reduce frequent and intense inter-parental conflict benefit all children in a family, children with specific temperament or constitutional traits (e.g., negative affect) may benefit from additional individualized intervention targeting their negative appraisals of that conflict.

The present study also identified genetic influences on three of the four CPIC subscales as well as significant genetic overlap between threat and internalizing problems, between self-blame and externalizing problems, and between triangulation/stability and both internalizing and externalizing. Such results are clearly consistent with recent work using a Children-of-Twins design (Harden et al., 2007; Schermerhorn et al., 2011) as well as past work pointing toward gene-environment correlation as a potential mechanism underlying the relationship between conflict and child adjustment problems (Feinberg et al., 2005; Horwitz et al., 2010; Neiderhiser et al., 1999). Furthermore, because the CPIC provides multiple dimensions of inter-parental conflict from the child's perspective, specificity in these relationships could also be determined (e.g.., rGE involving threat and internalizing problems and rGE involving self-blame and externalizing problems). Such findings are fully consistent with the specific relationships between threat and internalizing and self-blame and externalizing problems that have been extensively documented in developmental and family work (Buehler, Lange, & Franck, 2007; Rhoades, 2008).

The specificity of these relationships may also make sense when considering different types of gene-environment correlation. Children with externalizing problems may be more likely to evoke arguments between their parents, causing these youth to surmise (perhaps somewhat accurately) that their behavior is indeed a factor in their parents' marital disagreements, an example of an *evocative rGE*. This type of relationship would then emerge as significant genetic correlation between the CPIC self-blame scale and externalizing problems (which was in fact observed in the current study). Similarly, parents who engage in frequent and intense conflict with one another about their children (i.e., those high on conflict properties) may evidence higher levels of externalizing problems themselves. To the extent that their externalizing behaviors are genetically influenced, they would then be passed along to their children via both genetic and environmental (e.g., exposure to high levels of marital conflict) mechanisms. This sort of "double whammy" is referred to as passive rGE, and would thus emerge as a significant shared environmental correlation (such as that observed between conflict properties and externalizing), since it is theoretically invariant across zygosity. Passive rGE are expressly circumvented by the examination of non-genetically related family members. Adoption designs, for example, can elegantly evaluate and distinguish between passive and evocative rGE effects (see Klahr et al., 2011). Recent work using this design has indicated that spillover effects of marital hostility do indeed impact parenting and subsequent child functioning, even among genetically-unrelated parents and children (Stover et al., 2012). Thus, initial evidence indicates that more than just passive rGE processes underlie the relationship between inter-parental conflict and child adjustment.

Lastly, it is important to consider the current findings in light of theoretical models (e.g., emotional security, family systems) regarding the relationship between inter-parental conflict and child adjustment. The findings of common environmental influences on conflict properties, triangulation/stability, and child behavior can be viewed as supporting a family systems perspective. That is, experiences within the family, including severity of conflict and triangulation between members, serves to increase youth behavioral difficulties for all children within a family (Richmond & Stocker, 2008). Additionally, the findings of common genetic influences on appraisals of self-blame and externalizing, and threat and internalizing, are supportive of the emotional security hypothesis, which posits these appraisals, which are likely influenced by genetic and/or temperamental factors represent the proximal processes by which conflict impacts child adjustment (Davies & Cummings, 1994). Further, the finding of common genetic influences between appraisals and behavior problems supports recent work demonstrating that children's internal insecure representations of parent-child relationships are an intermediate mechanism by which exposure to parental discord impacts behavioral and academic functioning (Sturge-Apple et al., 2008).

Limitations

Although the current work is bolstered by the use of child reports of inter-parental conflict, there are limitations worth noting. First, although we found no indications of sex and age differences, our sample was confined to middle childhood. It may be the case that these relationships are different in older adolescents and/or in preschool children. Future work should continue to consider a potential moderating role of age on these relationships, particularly given the reciprocal interchanges between genetic and environmental influences across development. Additionally, the age range of the current sample (6-11 years) is slightly younger than the original sample used to develop the CPIC (ages 9-12) and recent work (including portions of this sample) indicates some potential issues with age-invariance of the CPIC scales across childhood and adolescence (Nigg et al., 2009). Given that the age-range of the current sample is restricted to middle childhood, it is less likely that problems with age-invariance have impacted the current results. Although extant work has demonstrated the utility of the CPIC in both older (Siffert, Schwarz, & Stutz, 2012) and younger (McDonald & Grych, 2006) children, issues related to age-invariance should be explored in future work on the CPIC. Similarly, reliance on a behavioral problem scale, such as the CBCL, may have limitations for understanding other functional impairments (e.g., academic, interpersonal) associated with exposure to inter-parental conflict.

Lastly, the current sample relied on parent reports of internalizing problems, which may represent an underestimate relative to child reports, as well as lead to inflated estimates of genetic and shared environmental influences (Burt, 2009). To preliminarily evaluate this possibility, models were re-analyzed using child interview reports of anxious/depressed and aggression/rule-breaking problems obtained via the Semi-Structured Clinical Interview for Children and Adolescents (SCICA). In virtually all cases, the genetic and environmental correlations between these SCICA scales and the CPIC were notably similar in magnitude and significance to those obtained using parent-report. However, the genetic overlap between anxious/depressed behaviors and triangulation/stability and threat was no longer significant when examining child report, a difference that may be related to the lower reliability of child-report of internalizing problems (α=.60) compared to parent-report (α=.90). Future research would benefit from examination of these relationships using combined information from multiple informants of child behavioral issues (van der Ende, Verhulst, & Tiemeier, 2012).

Overall, results from the current study indicate that the CPIC is a potentially useful tool for researchers interested in further investigation of the complex developmental consequences of exposure to inter-parental conflict using genetically-informed designs.

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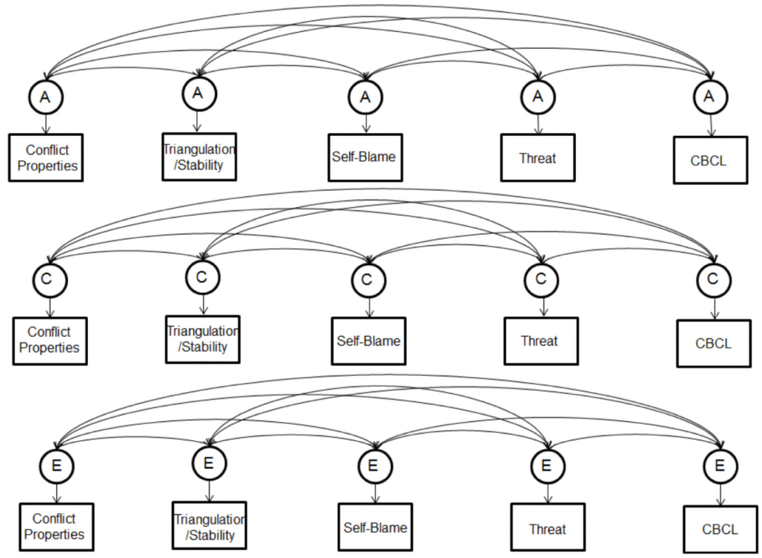

Figure 1. Path diagram of correlated factors model for CPIC scales and CBCL behavioral outcomes

Note. In this model, all of the genetic, shared, and non-shared environmental correlations between each of the factors are estimated. Here, the model is presented separately for genetic correlations (A), shared environment correlations (C), and non-shared environment correlations (E) for ease of presentation. Each pairwise correlation between the genetic, shared, and non-shared environmental influences on the CPIC and CBCL scales is calculated from the model parameter estimates.

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Table 1

Means and standard deviations of CPIC and CBCL scales by sex and zygositya

	Boys		Girls	
	MZ	**DZ**	**MZ**	**DZ**
Conflict Properties	20.6 (5.2)	19.9 (4.6)	19.5 (4.9)	19.8 (4.8)
Triangulation/Stability	17.6 (4.8)	17.4 (4.8)	17.1 (5.0)	16.6 (4.6)
Self-Blame	11.7 (2.9)	12.1 (3.1)	10.9 (2.6)	11.0 (2.5)
Threat	10.1 (3.0)	10.1 (3.3)	10.0 (3.1)	9.9 (3.0)
CBCL Internalizing	5.6 (5.4)	5.9 (5.2)	4.8 (4.4)	5.8 (5.4)
CBCL Externalizing	6.0 (6.2)	7.6 (7.0)	4.6 (5.1)	5.6 (6.3)

Note. MZ = monozygotic twins, DZ = dizygotic twins. Means for each scale were summed from each of the scales respective items.

Table 2

Phenotypic and intraclass correlations for CPIC and CBCL scales by zygosity

	CP-A	TS-A	SB-A	TH-A	INT-A	EXT-A	CP-B	TS-B	SB-B	TH-B	INT-B	EXT-B
1. CP-A	---	.39**	.19*	.26**	.08	.22**	**.48****	*.25***	*.08*	*.10*	*.12*	*.26**
2. TS-A	.56**	---	.35**	.53**	.14*	.18*	.30**	**.43****	*.18**	*.16**	*.15**	*.14**
3. SB-A	.22**	.35**	---	.14*	.06	.22*	.14*	.17*	**.20****	*.04*	*.02*	*.17**
4. TH-A	.43**	.43**	.20*	---	.19*	.04	.09	.16*	.02	**.24****	*.20**	*.06*
5. INT-A	.16*	.25**	.06	.39**	---	.49**	.10	.07	.05	.18*	**.38****	*.22**
6. EXT-A	.28**	.39**	.25*	.11	.56**	---	.16*	.25**	.19*	.06	.22*	*.39***
7. CP-B	**.52****	.45**	.17*	.20**	.07	.20*	---	.43**	.36**	.22**	.05	.16*
8. TS-B	*.42***	**.57****	.36**	.23**	.16*	.14*	.40**	---	.51**	.45**	.37**	.50**
9. SB-B	*.16**	*.22**	**.33****	.09	.08	.24*	.22*	.28**	---	.28*	.06	.18*
10. TH-B	*.25***	*.26**	*.13*	**.31****	.19*	.09	.25**	.44**	.21*	---	.27**	.06
11. INT-B	*.08*	*.17**	*.01*	*.30***	**.52****	.38**	.15	.18*	.11	.25**	---	.49**
12. EXT-B	*.20**	*.22**	*.28***	*.03*	*.37***	**.56****	.27**	.16*	.23*	.06	.46**	---

Note. CP=Conflict Properties, TS=Triangulation/Stability, SB=Self-Blame, TH=Threat, INT=internalizing problems, EXT=externalizing problems. A variables are for twin A, B variables are for Twin B (e.g, CP-A is the conflict properties score for twin A, while CP-B is the conflict properties score for twin B). MZ twin correlations are on the lower half of the diagonal, DZ twin correlations are on the upper half of the diagonal. Intraclass correlations are bolded, cross-twin cross-trait correlations are italicized.

*indicates correlation significant at p<.05

**indicates correlation significant at p<.01.

Table 3

Univariate estimates of genetic, shared environmental, and non-shared environmental influences on the CPIC scales and youth internalizing and externalizing problems

	%A	%C	%E
Conflict Properties	2.1 (0-19.8)	51.4 (44.3-57.9)*	46.8 (31.2-54.1)*
Triangulation-Stability	14.9 (1.2-25.6)*	42.9 (21.8-51.6)*	42.2 (36.5-53.3)*
Self-Blame	31.1 (10.7-42.9)*	4.7 (0-19.8)	64.5 (55.3-74.6)*
Threat	12.8 (1.1-24.3)*	17.6 (2.5-33.6)*	69.6 (59.6-79.9)*
Internalizing Problems	44.0 (22.5-62.1)*	14.5 (2.5-32.2)*	41.5 (34.9-49.4)*
Externalizing Problems	46.3 (27.2-63.8)*	19.6 (4.5-35.2)*	34.2 (28.5-41.1)*

Note.

A= additive genetic factors, C=shared environmental factors, E=non-shared environmental factors.

* indicates estimate is significant at p<.05.

Table 4

Multivariate model fit statistics for CPIC and CBCL correlated factors models: Estimates of sex and age differences

	−2lnL	df	AIC	BIC	Δ-2lnL	Δdf	p
CPIC-INT Sex Differences	14117.08	5278	3519.08	-9749.94	--	--	-
CPIC-INT No Sex Differences	**14161.10**	**5323**	**3420.10**	**−9847.56**	**44.02**	**45**	**.51**
CPIC-EXT Sex Differences	13962.98	5278	3506.98	−9805.99	--	--	--
CPIC-EXT No Sex Differences	**14003.56**	**5323**	**3442.56**	**−9886.33**	**40.58**	**45**	**.66**
CPIC-INT Age Differences	14611.38	5462	3476.13	−10229.77	--	--	--
CPIC-INT No Age Differences	**14659.65**	**5507**	**3454.65**	**−10279.53**	**48.27**	**45**	**.34**
CPIC-EXT Age Differences	14540.13	5462	3476.13	−10265.13	--	--	--
CPIC-EXT No Age Differences	**14574.44**	**5507**	**3460.43**	**−10322.14**	**34.31**	**45**	**.88**

Note. In sex-differences and age-differences, parameter estimates were allowed to vary across sex (males versus females) and across age (6-8 year olds versus 9-12 year olds). In the no sex-differences and age-differences models, these parameter estimates were constrained to be equal. The best fitting models, as indicated by the lower AIC and BIC values, are in bold.

Table 5
Genetic and environmental correlations among the CPIC scales

Additive Genetic Correlations (r_A)				
	Conflict Properties	**Triangulation/Stability**	**Self-Blame**	**Threat**
Conflict Properties	---			
Triangulation/Stability	56 (−.19-.65)	---		
Self-Blame	.07 (−.82-.99)	.43* (.15-1.0)	---	
Threat	.38 (−.70-.70)	.51* (.05-1.0)	.20 (−.32-.44)	---
Shared Environmental Correlation (r_C)				
	Conflict Properties	Triangulation/Stability	Self-Blame	Threat
Conflict Properties	---			
Triangulation/Stability	.75* (.33-1.0)	---		
Self-Blame	.59 (−1.0-1.0)	.87 (−1.0-1.0)	---	
Threat	.18 (−.25-.41)	.93 (−1.0-1.0)	.91 (−.61-1.0)	---
Non-Shared Environmental Correlation (r_E)				
	Conflict Properties	Triangulation/Stability	Self-Blame	Threat
Conflict Properties	---			
Triangulation/Stability	.26* (.11-.42)	---		
Self-Blame	.15(−.06-.24)	.04 (−.03-.17)	---	
Threat	.21* (.10-.35)	.49* (.27-.58)	.21* (.04-.33)	---

Note. Correlations presented are from the best-fitting correlated factors model.

95% confidence intervals for each correlation are presented in parentheses.

*indicates correlations significant at p<.05.

Table 6

Overlap between CPIC scales and child internalizing and externalizing behaviors: Genetic and environmental correlations from correlated factors models

Internalizing Problems			
	r_A	**r_C**	**r_E**
Conflict Properties	.07 (−.80-.80)	.28(−.71-.71)	.19* (.05-.42)
Triangulation Stability	.57* (.30-.74)	.70* (.33-.80)	.03 (−.08-.18)
Self-Blame	.07 (−.81-.45)	1.0 (−1.0-1.0)	.18 (−.04-.52)
Threat	.82* (.57-.96)	1.0 (−1.0-1.0)	.58* (.31-.65)
Externalizing Problems			
	r_A	r_C	r_E
Conflict Properties	.06 (−.19-.62)	.78* (.22-1.0)	.19* (.03-.35)
Triangulation/Stability	.55* (.34-.78)	.50* (.31-1.0)	.09 (−.04-.18)
Self-Blame	.76* (.29-1.0)	1.0 (−1.0-1.0)	.12 (−.06-.19)
Threat	.18 (−.60-.61)	1.0 (−1.0-1.0)	.05 (−.14-.10)

Note.

95% confidence intervals are presented in parentheses. r_A indicates genetic correlation, r_C indicates shared environment correlation, and r_E indicate non-shared environment correlation.

*indicates significant correlation at p<.05.