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The Limits of Child Effects: Evidence for Genetically Mediated Child Effects on Corporal Punishment but Not on Physical Maltreatment

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Research on child effects has demonstrated that children's difficult and coercive behavior provokes harsh discipline from adults. Using a genetically sensitive design, the authors tested the limits of child effects on adult behavior that ranged from the normative (corporal punishment) to the nonnormative (physical maltreatment). The sample was a 1994–1995 nationally representative birth cohort of 1,116 twins and their families who participated in the Environmental Risk Longitudinal Study. Results showed that environmental factors accounted for most of the variation in corporal punishment and physical maltreatment. However, corporal punishment was genetically mediated in part, and the genetic factors that influenced corporal punishment were largely the same as those that influenced children's antisocial behavior, suggesting a child effect. The authors conclude that risk factors for maltreatment are less likely to reside within the child and more likely to reside in characteristics that differ between families.

For much of the last century, research on parent disciplinary practices has described how parents influence their children's development but has failed to consider how children's behavior might simultaneously influence the nature of their interactions with parents. Only in the past 30 years have researchers begun to explore the bidirectional nature of parent–child relations and concluded that much of what parents do is a response to children's behavior (e.g., Anderson, Lytton, & Romney, 1986; Bell & Chapman, 1986; Maccoby & Martin, 1983; O'Connor, 2002; Patterson, Reid, & Dishion, 1992). More recently still, some behavioral geneticists have questioned whether parents have any influence on their children's behavior beyond that which is transmitted genetically (Harris, 1998; Rowe, 1994). This article asks the following questions: What are the limits of children's influence on adults' behavior? and To what degree do children's coercive and disruptive behaviors elicit responses from adults that range from physically punitive to abusive?

A number of well-designed prospective studies have found that children who are physically disciplined or maltreated are at increased risk of engaging in violent antisocial behavior in childhood and adulthood (Cicchetti & Manly, 2001; Gershoff, 2002; Lansford et al., 2002; Widom, 1989). However, other studies have shown that children whose behavior is difficult and coercive elicit more harsh and inconsistent disciplinary responses from adults, suggesting a reciprocal cycle in which children's antisocial behavior elicits a punitive response from adults that, in turn, increases the likelihood that the child will engage in further antisocial behavior (Cohen & Brook, 1995; Kandel & Wu, 1995; Patterson et al., 1992). Thus, the association between children's experience of corporal punishment or maltreatment and their antisocial behavior may reflect an effect of punitive parenting practices on child

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behavior, an effect of child behavior on parenting practices, or a reciprocal process of mutual influence.

Behavioral geneticists have expanded research on child effects to show that it is often the heritable characteristics of children that elicit particular disciplinary responses from adults. Evidence for child effects on parenting comes from twin and adoption studies that differ with respect to the age of the sample, the measure of parenting, and the design of the study but show consistently that a wide range of parenting behaviors, as reported by children, parents, and observers, are heritable (for reviews, see O'Connor, 2002; Plomin & Bergeman, 1991; Reiss, Neiderhiser, Hetherington, & Plomin, 2000). In the language of quantitative behavioral genetics, parenting practices are said to be "genetically mediated" by heritable characteristics of the child.[1] If, for example, monozygotic twins are disciplined more similarly than dizygotic twins, it means that genetically influenced characteristics of the child explain why some children are disciplined more often than others. For instance, a child whose genotype directly or indirectly (e.g., in combination with environmental stressors) increases the likelihood that she or he will engage in disruptive oppositional behavior may be more likely to elicit a punitive response from adults than a child who does not share that genotype (or the environmental stressors that potentiate the behavioral expression of that genotype). In their seminal work on the interplay between genes and environments, Scarr and McCartney (1983) referred to this process as an "evocative" or "active" gene–environment correlation whereby children evoke a response from and thereby create their own environments. As may be clear, these findings from behavioral genetic studies showing genetic influences on parenting practices are a special case of the child effects developmental psychologists have been discussing for several decades.

Although a number of studies have demonstrated genetic influences on parent control strategies, relatively few of these have (a) identified what it is that children do to evoke punitive responses from adults, (b) shown that the genetic influences on children's behaviors are the same as the genetic influences on adults' control strategies, or (c) probed the limits of children's influence on adults' behavior toward them. Exceptions include findings from two adoption studies (Ge et al., 1996; O'Connor, Deater-Deckard, Fulker, Rutter, & Plomin, 1998). In a study of 45 adolescent adoptees and their families, Ge and colleagues (Ge et al., 1996) focused on adoptees who were presumed to be at genetic risk for antisocial behavior on the basis of their biological parents' psychopathology. They found that these children elicited more harsh and inconsistent discipline and less nurturant and involved parenting from their adoptive parents compared with adoptees whose biological parents did not have a history of disorder. Although the data were cross-sectional, this study also found evidence of reciprocal parent–child effects: Adoptees' antisocial behavior was influenced by and was an influence on mothers' (but not fathers') negative parenting. In a study of 88 adoptive families followed longitudinally from middle childhood to early adolescence, O'Connor and colleagues (O'Connor et al., 1998) found that children's genetically influenced externalizing problems elicited negative control from parents (i.e., guilt induction, hostility, withdrawal from relationship). However, the magnitude of genetic mediation was modest, and evidence was also found for a nongenetically-mediated effect of children's externalizing behavior on parents' negative control. In addition, analyses of twin data have shown that the association between parents' conflictual negative behavior toward their children and children's antisocial behavior was primarily accounted for by genetic factors, even controlling for the continuity of parent and child behavior over time (Neiderhiser, Reiss, Hetherington, & Plomin, 1999; Pike, McGuire, Reiss, Hetherington, & Plomin, 1996).

The present study is concerned with the degree to which heritable characteristics of children—specifically, their antisocial behavior—are associated with adults' behaviors that range in severity from corporal punishment to physical maltreatment. *Corporal punishment* is defined as "the use of physical force with the intention of causing a child to experience pain but not injury for the purposes of correction or control of the child's behavior" (Straus, 1994, p. 4). It differs from maltreatment because it does not result in significant physical injury (Gershoff, 2002). Whereas child maltreatment is relatively uncommon, corporal punishment is a normative disciplinary practice among parents of young children, with 94% of American parents reporting that they had spanked their children by the time the children were 3 or 4 years old (Straus & Stewart, 1999) and over 90% of United Kingdom parents reporting that they had physically disciplined their children by the time the children were 11 years old (Nobes, Smith, Upton, & Heverin, 1999). Corporal punishment is administered most commonly among children ranging in age from 5–8 years (Gallup, Moore, & Schussel, 1995); children studied for this article were 5 years old.

Whereas children's coercive and disruptive behavior may provoke normative control strategies like corporal punishment, it is less likely to elicit physical maltreatment, risk for which is most strongly influenced by characteristics of the perpetrators and by the social context in which families reside (Azar, 2002; Belsky, 1993; Jaffee, in press). Consistent with the possibility that characteristics of adults and family environments, but not of children, influence the likelihood that children will be maltreated, a twin study showed that similarities between children in their experience of maltreatment were not accounted for by their genetic similarity (Jaffee, Caspi, Moffitt, & Taylor, 2004). This finding suggested that children's heritable characteristics do not provoke abuse. The current study extends previous work by (a) investigating genetic

[1] When estimates of genetic effects on parenting practices are based on how parents or observers report that parents treat their twin children, genetic influences on the parenting measure are interpreted as reflecting heritable child characteristics. Likewise, when estimates of genetic effects on parenting practices are based on how twin children report that they themselves have been treated, genetic influences on the parenting measure also reflect children's heritable perceptual biases. In contrast, when estimates of genetic effects on parenting are based on how twin adults describe the way they treat their own children, genetic influences on the parenting measure are interpreted as capturing heritable characteristics of parents (Plomin, Reiss, Hetherington, & Howe, 1994). In our examples (and in our data), reports of parenting are provided by parents or observers with reference to twin children. Thus, genetic influences on corporal punishment or maltreatment are interpreted as reflecting heritable child characteristics and not heritable characteristics of parents. However, to the degree that there is a diluted hereditary resemblance between parents and children (i.e., they share 50% of their genes, on average), genetic influences on parenting measures like corporal punishment or maltreatment may also reflect the parents' genotype to some degree.

and environmental influences on physical maltreatment as well as on normative control strategies like corporal punishment, (b) by identifying specific child behaviors that are associated with corporal punishment and physical maltreatment and that may account for genetic influences on those adult behaviors, and (c) by specifying which etiological factors corporal punishment and physical maltreatment share in common and which are distinctive. This investigation explores the limits of child effects on adults' behavior.

On the basis of our review of the literature, we predicted that the association between children's experience of corporal punishment and their antisocial behavior would be genetically mediated. Support for this hypothesis would be found if (a) we detected significant genetic influences on corporal punishment and (b) we found that the genetic factors that influenced children's antisocial behavior were the same as those that influenced corporal punishment and accounted for a large portion of the phenotypic association between the two. On the basis of our hypothesis that children do not influence adults' behavior outside the normal range, we predicted that although corporal punishment and physical maltreatment would have some common causes, heritable characteristics of children would influence the former but not the latter.

Method

The Environmental Risk (E-Risk) Longitudinal Twin Study Sample

Participants are members of the E-Risk Longitudinal Twin Study, which investigates how genetic and environmental factors shape children's development. The sampling frame from which the E-Risk families were drawn was two consecutive birth cohorts (1994 and 1995) in a birth register of twins born in England and Wales (Trouton, Spinath, & Plomin, 2002). Of the 15,906 twin pairs born in these 2 years, 71% joined the register.

The E-Risk Study probability sample was drawn using a high-risk stratification strategy. High-risk families were those in which the mother had her first birth when she was 20 years of age or younger. We used this sampling (a) to replace high-risk families who were selectively lost to the register via nonresponse and (b) to ensure sufficient base rates of problem behavior, given the low base rates expected for 5-year-old children. Age at first childbearing was used as the risk-stratification variable because it was present for virtually all families in the register, it is relatively free of measurement error, and early childbearing is a known risk factor for children's problem behaviors (Maynard, 1997; Moffitt & E-Risk Study Team, 2002). The high-risk sampling strategy resulted in a final sample in which one third of study mothers constitute a 160% oversample of mothers who were at high risk on the basis of their young age at first birth (15–20 years), whereas the other two thirds of study mothers accurately represent all mothers in the general population (aged 15–48 years) in England and Wales in 1994–1995. Demographic estimates are derived from the General Household Survey (Bennett, Jarvis, Rowlands, Singleton, & Haselden, 1996). To provide unbiased statistical estimates from the whole sample that can be generalized to the population of British families with children born in the 1990s, the data reported in this article were corrected with weighting to represent the proportion of maternal ages in that population.

The E-Risk Study sought a sample size of 1,100 families to allow for attrition in future years of the longitudinal study while retaining statistical power. An initial list of families who had same-sex twins was drawn from the register to target for home visits, with a 10% oversample to allow for nonparticipation. Of the 1,203 families from the initial list who were eligible for inclusion, 1,116 (93%) participated in home-visit assessments when the twins were age 5 years, forming the base sample for the study; 4% of families refused, and 3% were lost to tracing or could not be reached after many attempts. With parent's permission, questionnaires were mailed to the children's teachers, and teachers returned questionnaires for 94% of cohort children. Written informed consent was obtained from mothers. The E-Risk Study has received ethical approval from the Maudsley Hospital Ethics Committee.

Zygosity was determined using a standard zygosity questionnaire, which has been shown to have 95% accuracy (Price et al., 2000). Ambiguous cases were zygosity-typed using DNA. The sample includes 55% monozygotic (MZ) twins and 45% dizygotic (DZ) twins. Sex is evenly distributed within zygosity (49% male).

Measures

Corporal punishment and child physical maltreatment were assessed separately for each twin by interviewing mothers with the standardized clinical interview protocol from the Multi-Site Child Development Project (Dodge, Bates, & Pettit, 1990; Dodge, Pettit, Bates, & Valente, 1995; Lansford et al., 2002). The same set of questions about nonphysical discipline, corporal punishment, and physical maltreatment was asked about each twin, and the interviews about each twin were separated by 1.5 hr of questions on other topics. The interview protocol was designed by Dodge and colleagues (Dodge et al., 1990, 1995; Lansford et al., 2002) to enhance mothers' comfort with reporting valid discipline and child maltreatment information while also meeting researchers' legal and ethical responsibilities for reporting. Under the United Kingdom Children Act (Department of Health, 1989), our responsibility was to secure intervention if maltreatment was current and ongoing. At the start of the interview about discipline and maltreatment, the interviewer explained to the mother that if she reported maltreatment that had occurred in the child's first 4 years and was not ongoing, that information could remain confidential. However, if she reported maltreatment that occurred in the year prior to the interview and the risk to the child was ongoing, the E-Risk Study would be under legal obligation to assist the family to get help. Thus, when mothers gave informed consent to proceed with the interview, they understood that a report of recent ongoing maltreatment would constitute a request for help (if the maltreatment was not already known to authorities). The interview did not ask directly about the timing of incidents and therefore mothers who wished to report maltreatment while avoiding intervention could have opted to describe maltreatment as happening in the past.

We interviewed mothers about maltreatment instead of ascertaining cases from Child Protective Service registers for three reasons. First, official record data identify only a small proportion of cases, which may be a biased unrepresentative subset (Walsh, McMillan, & Jamieson, 2002; Widom, 1988). Second, because of time delays in detection, investigation, and legal proceedings against perpetrators, official record data sources tend not to record children as confirmed cases until older ages and the children in our sample were 5-year-olds. Third, searching child protection records for this sample would have required parental consent, placing record data at the same potential risk of parental concealment as mothers' reports.

The discipline and maltreatment interview protocol has (a) good concurrent validity as evidenced by correlations above .60 with mothers' reports of their child-directed aggression using the Conflict Tactic Scales (Dodge et al., 1990; Straus & Gelles, 1988), (b) good interreporter reliability as evidenced by a correlation of .60 between mothers' and fathers' reports in 396 couples (Dodge et al., 1995), and (c) good predictive validity as evidenced by significant 12-year prediction from preschool maltreatment to outcomes in Grade 11, including increased violence, school absenteeism, anxiety and depressive symptoms, and posttraumatic stress disorder symptoms, controlling for a variety of social and family risk factors (Lansford et al., 2002).

Corporal punishment was assessed by asking mothers whether the child had experienced a variety of disciplinary practices in the past year, some of which assessed nonphysical discipline (e.g., "isolation," "withdrew privi-

leges") and three of which assessed corporal punishment ("grabbing or shaking," "smacking or hitting," or engaging in "other physical discipline"). A score of 1 was assigned if the mother reported that a particular disciplinary practice had been used with the child, and a score of 0 was assigned if the disciplinary practice had not been used. If mothers reported any form of corporal punishment, they were then asked how often in the past year the child was physically punished, with responses ranging from 0 (*never*) to 5 (*daily*). Children who did not receive any corporal punishment were assigned a score of 0 on the frequency variable. Mothers were then asked these same questions about the variety of disciplinary practices used with the child and the frequency with which corporal punishment was used during the child's first 4 years. We created variety and frequency variables based on mothers' reports of corporal punishment across the children's first 5 years. The variety variable indexes how many different kinds of physical disciplinary practices were used ($M = 1.63$, $SD = 0.82$). The frequency variable indexes how often, on average, corporal punishment was used with the child ($M = 1.59$, $SD = 1.15$). The variety and frequency scores across the child's first 5 years were highly correlated ($r = .65$, $p < .01$). To create the corporal punishment composite variable used in our analyses, we standardized and summed the variety and frequency scores ($M = 0.03$, $SD = 1.78$). Eighty-seven percent of children had experienced corporal punishment at least once in their first 5 years (weighted and unweighted prevalences were identical).

Following the questions about nonphysical discipline and corporal punishment, mothers were asked standardized probe questions about potential physical maltreatment, including "When [name] was a toddler, do you remember any time when she/he was disciplined severely enough that she/he may have been hurt?" and "Did you worry that you or someone else [such as a babysitter, a relative, or a neighbor] may have harmed or hurt [name] during those years?" (1% of mothers declined to answer the questions). Questions were carefully worded to avoid implying that the mother was the perpetrator so that mothers might feel more willing to report that a child had been maltreated. In cases where mothers reported any physical maltreatment, interviewers probed mothers for details about the incident and recorded notes. Interviewers coded the likelihood that the child had been maltreated on the basis of the mothers' narratives. This classification showed 90% agreement between coders in our study and adequate intercoder agreement ($\kappa = .56$) in Dodge et al.'s study (Dodge, Pettit, & Bates, 1994; Dodge et al., 1995). The 10% of codes that disagreed tended to reflect uncertainty about whether physical maltreatment was probable or definite. All children in the maltreatment group experienced some sort of physical maltreatment. Many children undoubtedly had experienced additional sexual abuse, psychological abuse, or neglect, but this was not systematically ascertained. On the basis of the mother's report of the severity of discipline and the interviewer's rating of the likelihood that the child had been physically maltreated, children were coded as having not been, possibly been, or definitely been physically maltreated. Examples of possible physical maltreatment in our sample ($n = 273$ children) included instances in which the mother reported that she smacked the child harder than intended and left a mark or bruise or cases in which social services were contacted by schools, neighbors, and/or family members out of concern that the child was being physically maltreated. Examples of definite physical maltreatment included children who were beaten by a teenaged stepsibling, punished by being burned with matches or thrown against doors, had injuries (e.g., fractures or dislocations) from neglectful or abusive care, or were formally registered with a social services child protection team. The prevalence of such definite serious physical maltreatment as defined in this sample was 1.5% ($n = 34$ children). For the purposes of our analyses, the child physical maltreatment variable was recoded into a dichotomous variable representing children who experienced no physical maltreatment (unweighted, prevalence = 86%; weighted to represent the population, prevalence = 88%) versus a combined group of children who experienced possible or definite physical maltreatment (unweighted, prevalence = 14%; weighted to represent the population, prevalence = 12%). The prevalence of physical maltreatment was similar among MZ (11%) and DZ (14%) twins. Our combined prevalence of 12% resembles the 15% prevalence estimate reported by Dodge and colleagues (Dodge et al., 1990), whose measurement protocol we used. Our prevalence rate of 1.5% for definite physical maltreatment is consistent with physical maltreatment estimates of 1.5% and 2.6% from population surveys in North America (Bland & Orn, 1986; Egami, Ford, Greenfield, & Crum, 1996).

Children's antisocial behavior was assessed at 5 years with the Achenbach family of instruments (Achenbach, 1991a, 1991b). The Aggression and Delinquency scales were supplemented with *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (American Psychiatric Association, 1994) items assessing conduct and oppositional defiant disorder. Mother and teacher reports of antisocial behavior correlated .29 ($p < .01$), which is typical of interrater agreement about behavioral problems (Achenbach, McConaughy, & Howell, 1987). Mother and teacher reports of children's behavior problems were summed (items scored from 0 to 2). Scores ranged from 0 to 130 ($M = 21.17$, $SD = 16.27$). The internal consistency of the combined score was .94.

Results

The results are presented in six sections. In the first section, we present prevalence rates of corporal punishment and physical maltreatment and describe the association between the two as well as their association with children's antisocial behavior. In the second, third, and fourth sections, we test whether children's experience of corporal punishment is genetically mediated by their antisocial behavior. In the remaining sections, we test these hypotheses about children's experience of physical maltreatment, and we determine what accounts for the association between corporal punishment and physical maltreatment.

Prevalence Rates of Corporal Punishment and Maltreatment

Corporal punishment was far more common among families than maltreatment; 87% of children had experienced corporal punishment by the time they were 5 years old, but only 12% had been possibly or definitely maltreated. Among the children who had ever received corporal punishment, 87% had never been maltreated. Among the children who were maltreated, only 6% had never experienced corporal punishment (suggesting that among the 6%, the abuse perpetrator was not the parent). Although the vast majority of children who experienced corporal punishment had never been maltreated, having been physically disciplined increased the odds of having been maltreated by 2.5 times (odds ratio = 2.56, 95% confidence interval [CI] = 1.27 to 5.19, $p < .01$). All associations among corporal punishment, maltreatment, and child antisocial behavior were statistically significant. The Pearson correlation between corporal punishment and child antisocial behavior was .27 ($p < .01$). Children who had been physically maltreated ($M = 29.16$, $SD = 19.35$) had significantly higher antisocial behavior scores than children who had not been maltreated ($M = 20.05$, $SD = 15.47$; $B = 9.11$, $SE = 1.41$, $\beta = .18$, $p < .01$).

Are Children's Experiences of Corporal Punishment Genetically Mediated?

We conducted maximum-likelihood univariate model-fitting analyses using Mx software (Neale, Boker, Xie, & Maes, 2002) to

determine the extent to which individual differences in children's experience of corporal punishment were accounted for by genetic and environmental factors (Neale & Cardon, 1992). These behavioral genetic model-fitting analyses rely on the different level of genetic relatedness between MZ and DZ twin pairs to estimate the contribution of genetic and environmental factors to individual differences in a given phenotype. Phenotypes include any behavior or characteristic that is measured separately for each twin, such as each twin's score on a behavior problem checklist or each twin's experience of corporal punishment. Population variation on any phenotype may be partialed into an additive genetic component and two types of environmental components by using the following logic. First, MZ twins share all their genes, but DZ twins, like all nonidentical siblings, share half of their polymorphous genes, on average. Polymorphous genes are those associated with differences among people. For example, genes influencing eye color are polymorphous, but genes determining that people have eyes are not. As such, a genetic contribution to antisocial behavior or corporal punishment is indicated when the similarity of MZ twins is greater than the similarity of DZ twins. In model-fitting terms, this yields a significant variance component called A (additive genetic variance). Second, MZ twins' genetic similarity is twice that of DZ twins, and therefore, if nothing more than genes were influencing behavior, then MZ twins should be at least twice as similar as DZ twins. If not, this indicates that something more than genes has made the twins similar (i.e., environments that the siblings share in common must have enhanced their similarity). In model-fitting terms, this yields a significant variance component called C (common, or shared, environmental variance). Third, if MZ twins, despite sharing all their genes, are not perfectly identical in their experience of corporal punishment or antisocial behavior, this indicates that nonshared experiences unique to each family member reduce their similarity. In model-fitting terms, this yields a significant variance component called E (child-specific environmental variance as well as measurement error).

Because the latent variables A, C, and E are unmeasured, they do not have a natural scale and must be assigned a variance (i.e., the variance is fixed at 1.0). The goal of fitting different structural equations to twin data is to account for the observed covariance structure using the most parsimonious number of parameters. To compare the fit of different models, we used two model-selection statistics. The first was the chi-square goodness-of-fit statistic. Large values indicate poor model fit to the observed covariance structure. When two models are nested (i.e., identical with the exception of constraints placed on the submodel), the difference in fit between them can be evaluated with the chi-square difference, using as its degrees of freedom the *df* difference from the two models. When the chi-square difference is not statistically significant, the more parsimonious model is selected, as the test indicates that the constrained model fits equally well with the data. The second model-selection statistic was the root-mean-square error of approximation (RMSEA), which is an index of the model discrepancy, per degree of freedom, from the observed covariance structure (MacCallum, Browne, & Sugawara, 1996). Values less than .05 indicate close fit and values less than .08 indicate fair fit to the data (Browne & Cudeck, 1993). For detailed explanations of the statistical methods that operationalize the logic behind behavior genetic designs, see Plomin, DeFries, McClearn, and McGuffin (2001).

The top part of Table 1 presents the results of the univariate model for corporal punishment. Columns 1 and 2 show the within-pair twin correlations for children's experiences of corporal punishment separately for MZ and DZ twins. The magnitudes of the twin correlations for exposure to corporal punishment are consistent with those reported by other investigators in both adoption and twin studies (Deater-Deckard, Fulker, & Plomin, 1999; Wade & Kendler, 2000). To test the hypothesis that children's experience of corporal punishment was genetically mediated, we compared the full model with one in which genetic factors were constrained to have no effect on individual differences in corporal punishment. The constrained model fit significantly worse than the full model, $\chi^2(1, N = 1{,}096) = 90.56$, $p < .01$, indicating that children's experience of corporal punishment was significantly genetically mediated, in part. The best fitting model indicated that shared environmental factors accounted for 66% and genetic factors accounted for 25% of the variation in children's experience of corporal punishment, with nonshared environmental influences and measurement error accounting for the remainder of the variation.

Table 1
Within-Pair Twin Correlations for Corporal Punishment, Maltreatment, and Child Antisocial Behavior and Results of Univariate Model Fitting

	Within-pair *r*		Population variance attributable			Model fit statistics			
Variable	MZ	DZ	A	C	E	χ^2	*df*	RMSEA	$\chi^2_{\text{difference}}$
Corporal punishment	.90*	.79*	.25 (.19–.31)	.66 (.59–.71)	.10 (.09–.11)	2.99	3	.005	
A = 0				.85 (.83–.86)	.15 (.14–.17)	93.55*	4	.202	90.56*
Physical maltreatment	.77*	.71*	.07 (.00–.21)	.88 (.75–.96)	.05 (.02–.09)	2.88	3	.006	
A = 0				.94 (.91–.96)	.06 (.04–.09)	4.60	4	.011	1.72
Antisocial behavior	.75*	.30*	.73 (.64–.76)	.00 (.00–.09)	.27 (.24–.30)	11.61	3	.009	
A = 0				.57 (.53–.61)	.43 (.39–.47)	138.38*	4	.246	126.77*

Note. Numbers in parentheses represent the 95% confidence intervals. $\chi^2_{\text{difference}}$ is the difference in fit between the full model and the reduced model in which genetic factors are hypothesized to have no effect (A = 0). MZ = monozygotic; DZ = dizygotic; A = additive genetic effect; C = common environmental effect; E = unique environmental effect; RMSEA = root-mean-square error of approximation.
* $p < .01$.

Is Corporal Punishment Genetically Mediated by Children's Genetic Predisposition for Antisocial Behavior?

The hypothesis that corporal punishment is genetically mediated by children's antisocial behavior requires that children's antisocial behavior be heritable. Previous work in this sample has shown that the heritability of 5-year-old children's antisocial behavior ranges from 33% to 71%, depending on the informant, and that the heritability of antisocial behavior that is pervasive across settings is 82% (Arseneault et al., 2003). The bottom part of Table 1 shows the estimates of genetic and environmental influences on the measure of antisocial behavior used in this report. To test whether common genetic factors accounted for the association between children's experience of corporal punishment and their antisocial behavior, we specified a common factors model (Neale & Cardon, 1992). The common factors model tests whether there are genetic and environmental factors that influence corporal punishment and child antisocial behavior or whether the genetic or environmental factors that influence corporal punishment are largely distinct from those that influence children's antisocial behavior.

To estimate the common factors model, a Cholesky decomposition model was initially fit using Mplus software (Muthén & Muthén, 1998). In the Cholesky model, variation within the first phenotype (e.g., corporal punishment) is accounted for by latent additive genetic, shared environmental, and nonshared environmental factors. Variation within the second phenotype (e.g., antisocial behavior) is accounted for by the same genetic and environmental latent factors that influence corporal punishment as well as another set of latent genetic and environmental factors that account specifically for variation within antisocial behavior. The resulting parameters were transformed into those shown in Figure 1 according to the algebraic formulae presented by Loehlin (1996).

Figure 1 presents the results of the common factors model. The fit of the model was adequate, $\chi^2(11, N = 1{,}096) = 16.67$, $p = .12$, RMSEA = .031, and the results supported the hypothesis that corporal punishment is genetically mediated by children's antisocial behavior. That is, the phenotypic correlation between corporal punishment and antisocial behavior can be recovered by following tracing rules (Kenny, 1979) and summing the products of the paths that connect the phenotypes (e.g., $.49^2 + .04^2 + .19^2 = .28$). To determine how much of the phenotypic correlation ($r = .28$) is accounted for by genetic factors, the product of the paths connecting the two phenotypes via the latent genetic factors is calculated and divided by the overall phenotypic correlation (e.g., $.49^2/.28 = .86$). Thus, genetic factors accounted for 86% of the covariation between antisocial behavior and corporal punishment, with nonshared environmental factors accounting for most of the remainder. To formally test the hypothesis that children's experience of corporal punishment is mediated by genetic factors that also influence their antisocial behavior, we set the paths from the common genetic factor to the phenotypes equal to zero. If this model provided a good fit to the data, it would indicate that the association between corporal punishment and child antisocial behavior could be adequately described without reference to genetic factors that influence them both. The fit of the reduced model was significantly worse than the fit of the full model, $\chi^2_{\text{difference}}(1, N = 1{,}096) = 49.42$, $p < .01$. Thus, to the degree that there are genetic influences on variation in children's experience of corporal pun-

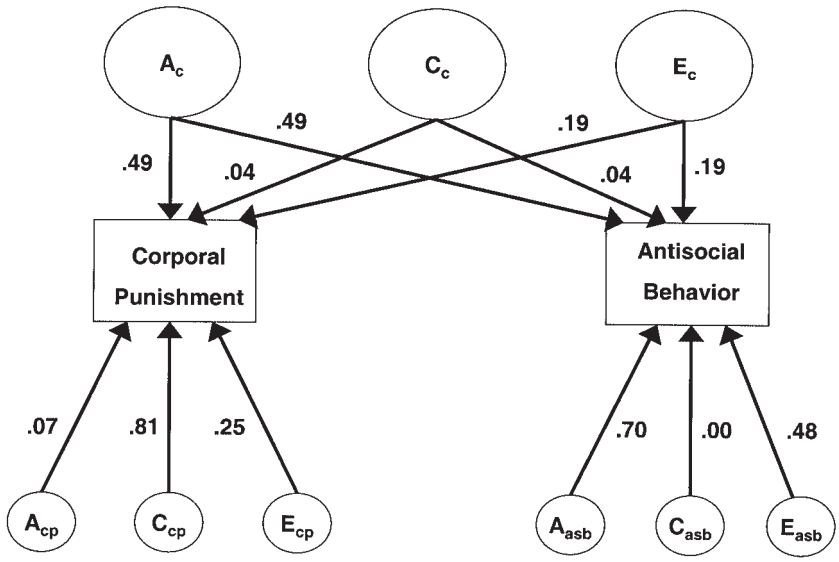

Figure 1. Common factors model of the association between corporal punishment and antisocial behavior. Parameter estimates are standardized and must be squared to obtain population variance in each phenotype attributable to genetic, shared environmental, or nonshared environmental factors. A_c, C_c, and E_c = genetic, shared environmental, and nonshared environmental factors (respectively) that are common to both corporal punishment and antisocial behavior; A_{cp} and A_{asb} = genetic factors that are specific to corporal punishment and antisocial behavior, respectively; C_{cp} and C_{asb} = shared environmental factors that are specific to corporal punishment and antisocial behavior, respectively; E_{cp} and E_{asb} = nonshared environmental factors that are specific to corporal punishment and antisocial behavior, respectively.

ishment, these also account for individual differences in children's antisocial behavior.[2]

Addressing Issues of Temporality in the Association Between Corporal Punishment and Children's Antisocial Behavior

The univariate and bivariate analyses of corporal punishment showed that there were significant genetic influences on corporal punishment and that genetic factors accounted for most of the covariance between corporal punishment and children's antisocial behavior. However, these results do not allow us to plausibly test the hypothesis that children's antisocial behavior evokes physical discipline because children's antisocial behavior was not measured prior to the assessment of corporal punishment. A partial solution to this problem was to examine only those instances of corporal punishment that occurred in the year before children turned 5 years of age so that our measure of children's antisocial behavior would at least be concurrent with (if not temporally prior to) the measure of corporal punishment. As reported by their mothers, 78% of children were physically disciplined in the year before they turned 5, but only 14% of those children had ever been physically maltreated. Similar to the approach described in the Method section, we standardized scores representing the variety of disciplinary practices used in the past year (ranging from 1 to 3; $M = 0.82$, $SD = 0.47$) and scores representing the frequency of corporal punishment in the past year (ranging from 0 to 5; $M = 1.61$, $SD = 1.26$). The Pearson correlation between past-year corporal punishment variety and frequency scores was .64 ($p < .01$). The standardized frequency and variety scores were summed to create a measure of total past-year physical discipline ($M = -0.02$, $SD = 1.79$).

Univariate analyses of past-year corporal punishment replicated the findings reported in Table 1. Genetic factors accounted for 21% of the variation in past-year corporal punishment (95% CI = .13 to .29), with shared environmental factors accounting for an additional 62% (95% CI = .54 to .69) and nonshared environmental factors accounting for the remaining 17% (95% CI = .15 to .19) of the variance. Genetic influences on corporal punishment were significantly different from zero, as indicated by the significant decrement in model fit when the influence of genetic factors was hypothesized to be zero, $\chi^2_{\text{difference}}$ (1, $N = 1{,}104$) = 32.10, $p < .01$.

The phenotypic correlation between children's antisocial behavior and past-year corporal punishment was .28 ($p < .01$). Results of the bivariate model replicated those reported in Figure 1. Genetic factors that were common to past-year corporal punishment and children's antisocial behavior accounted for 76% of the phenotypic correlation between the two. The fit of the bivariate model deteriorated significantly when common genetic influences on past-year corporal punishment and antisocial behavior were hypothesized to be zero, $\chi^2_{\text{difference}}$ (1, $N = 1{,}104$) = 29.78, $p < .01$.

Are Children's Experiences of Physical Maltreatment Genetically Mediated?

Because maltreatment was a dichotomous variable, analyses of genetic and environmental influences on maltreatment were conducted using contingency table data and liability threshold models in Mx (Neale et al., 2002). Although liability threshold models provide unbiased estimates of genetic and environmental variance components when the prevalence of the dichotomous outcome is as low as 10% (prevalence rates of physical maltreatment in our sample were 12%), they are underpowered to detect genetic and environmental effects relative to models that account for variation in continuously distributed outcomes (Neale, Eaves, & Kendler, 1994). To demonstrate that genetic influences on maltreatment are significant, we must have sufficient power to reject a model of purely environmental effects on maltreatment (i.e., a CE model) in favor of a model that freely estimates genetic and environmental influences on maltreatment. We conducted power analyses following recommendations by Neale and colleagues (Neale et al., 1994) and determined that our model had power of .78 to reject a model of purely environmental influences on maltreatment (i.e., a CE model) in favor of a model that hypothesized genetic and environmental influences on maltreatment (i.e., an ACE model) if true heritability was as low as .20. However, power was poor (power = .40) to reject a CE model in favor of an ACE model if true heritability was as low as .10.

The middle part of Table 1 shows genetic and environmental influences on children's experience of maltreatment. To test the hypothesis that children's experience of maltreatment is genetically mediated, we compared the fit of the full model (ACE) to one in which genetic factors were constrained to have no effect on individual differences in exposure to maltreatment (CE). The full model did not fit significantly better than a more parsimonious model in which genetic influences on children's experience of maltreatment were constrained to be zero, $\chi^2(1, N = 1{,}115) = 1.72$, *ns*. Thus, unlike children's experience of corporal punishment, genetic influences were not needed to account for individual differences in children's experience of maltreatment. The best-fitting model indicated that shared environmental factors accounted for 94% of the variance in children's experience of maltreatment, with nonshared environmental influences and measurement error accounting for the remainder. We must note, however, that given the 95% CI around our point estimate for genetic influences on maltreatment, it is likely that our model was underpowered to reject the CE model in favor of a model specifying both genetic and environmental influences on maltreatment.

Identifying Common Precursors of Corporal Punishment and Physical Maltreatment

The results of the univariate analyses showed that variation in children's experience of corporal punishment was influenced primarily by genetic and shared environmental factors and that variation in children's experience of maltreatment was influenced primarily by shared and nonshared environmental factors. These results alone suggest that influences on corporal punishment and physical maltreatment differ (e.g., genetic factors influence the former but not the latter). However, these forms of physical

[2] Results were unchanged regardless of whether mother or teacher reports of children's antisocial behavior were analyzed separately. For example, the phenotypic correlation between teacher reports of children's antisocial behavior and corporal punishment was .15 ($p < .01$). Genetic factors accounted for 80% of this association.

discipline are related, as demonstrated by the fact that in our sample, children who received corporal punishment were at increased risk of experiencing maltreatment. This suggests that corporal punishment and maltreatment must have some similar origins (or that one causes the other). To formally test for etiological similarities, we estimated a common factors model of the association between corporal punishment and maltreatment. A Cholesky decomposition model was initially fit to the data using Mplus software (Muthen & Muthen, 1998). Tetrachoric correlations were used to estimate the model because of the categorical nature of the maltreatment variable. The resulting parameters were transformed into the parameter estimates in Figure 2 using the algebraic formula presented by Loehlin (1996). The fit of the model was adequate, $\chi^2(14, N = 1{,}096) = 15.26$, $p = .36$, RMSEA = .013. The results demonstrated that 74% of the covariation between corporal punishment and maltreatment was accounted for by shared environmental factors that were common to both. To test whether genetic factors were needed to account for the covariation of corporal punishment and maltreatment, we set all common genetic influences equal to zero. The constrained model did not fit significantly worse than the full model, $\chi^2_{\text{difference}}(1, N = 1{,}096) = 3.36$, *ns*. Thus, corporal punishment and maltreatment co-occur because of factors that differ between families but not because both are genetically mediated by child behavior.

Discussion

Implications for Theory

This study showed that the reason some children are more likely than others to be physically maltreated is largely explained by factors that differ between families. Similarly, the fact that some children are more likely than others to be physically disciplined is predominantly explained by factors that differ between and within families. These findings highlight the limits of child effects in much the same way that behavioral genetics research on the family has highlighted the "limits of family influence" (Rowe, 1994). Unquestionably, children play a significant role in shaping their environmental experience (Scarr, 1992; Scarr & McCartney, 1983). Indeed, our results showed that genetic factors played a significant role in explaining why some children were more likely than others to experience normative physical disciplinary practices like spanking. However, children—particularly young children—are also subjected to certain experiences like maltreatment, over which they have little control and which have important implications for their developmental outcomes. We do not suggest that children can control whether they are spanked or smacked in response to their misbehavior—only that there is likely to be a contingent, genetically mediated relation between children's difficult coercive behavior and their experience of corporal punishment, whereas there is less likely to be such a contingent relation between children's behavior and their experience of maltreatment.

Research on child effects has shown that children's difficult and coercive behavior often elicits harsh discipline from parents in the form of shouting, threatening, or smacking (Reid, Patterson, & Snyder, 2002). Consistent with these findings, our results showed that genetic factors accounted for variation in children's experience of corporal punishment. Assuming that there is not a "corporal punishment gene," genetic influences on physical discipline must reflect heritable characteristics of children. In analyses that included past-year measures of corporal punishment that were

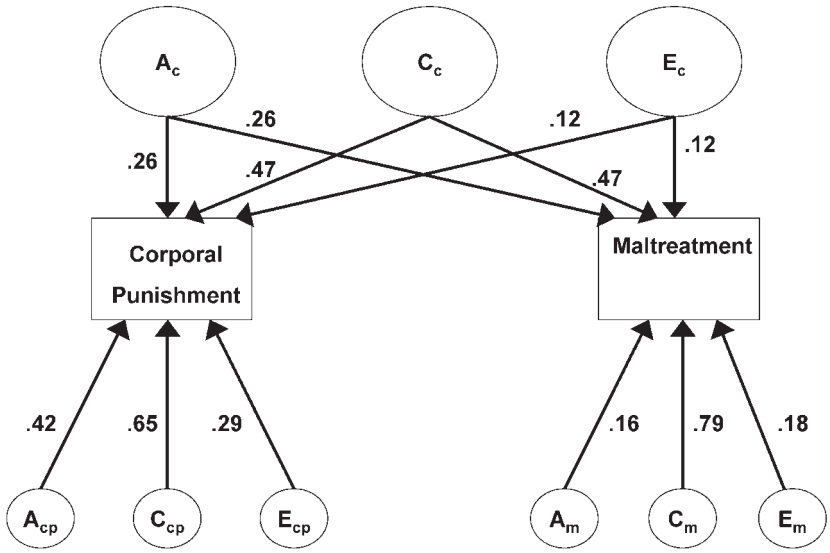

Figure 2. Common factors model of the association between corporal punishment and maltreatment. Parameter estimates are standardized and must be squared to obtain population variance in each phenotype attributable to genetic, shared environmental, or nonshared environmental factors. The effects of A_m and A_{cp} are not statistically significant. A_c, C_c, and E_c = genetic, shared environmental, and nonshared environmental factors (respectively) that are common to both corporal punishment and maltreatment; A_{cp} and A_m = genetic factors that are specific to corporal punishment and maltreatment, respectively; C_{cp} and C_m = shared environmental factors that are specific to corporal punishment and maltreatment, respectively; E_{cp} and E_m = nonshared environmental factors that are specific to corporal punishment and maltreatment, respectively.

temporally concurrent with measures of child antisocial behavior and in analyses that included measures of corporal punishment that spanned the children's first 5 years of life, we found that children's oppositional, aggressive, and coercive behavior was associated with the use of more frequent and more varied forms of physical discipline and that the genetic factors that influenced variation in corporal punishment also accounted for variation in child antisocial behavior. This provides suggestive evidence that heritable characteristics of children influence parenting in the normal range.

Our finding that both genetic and shared environmental factors accounted for individual differences in corporal punishment is consistent with one other study in which adult female twins and their parents were asked to report retrospectively on how often the parents had used corporal punishment to discipline each twin when the twins were children (Wade & Kendler, 2000). Their results showed that genetic factors accounted for a significant 19% and shared environmental factors accounted for 66% of the variation in mother-reported corporal punishment, whereas our results yielded estimates of 25% and 66%, respectively. However, our research is the first to explore the genetic and environmental origins of maltreatment and to show that corporal punishment and maltreatment are associated with children's antisocial behavior for different reasons. Whereas our findings suggest that children's genetically influenced aggressive and difficult-to-manage behavior may provoke incidents of corporal punishment, maltreatment is not genetically mediated by children's behavior. In contrast, maltreatment has been shown to influence children's antisocial behavior directly (Jaffee et al., 2004) and to exacerbate children's genetic risk for antisocial behavior (Caspi et al., 2002; Jaffee et al., in press).

Implications for Research

Not all child victims of maltreatment are abused by their parents, particularly their biological parents (Daly & Wilson, 1988). However, research suggests that, in many cases, maltreatment results from a parent losing control in the course of ordinary discipline (Gershoff, 2002). Our findings suggest that researchers who study the processes by which such disciplinary episodes become abusive episodes should look to aspects of the familywide environment as potential moderators of adults' behavior. A number of studies have shown that demographic risk factors (e.g., low education, single parenthood, neighborhood poverty), familial risk factors (e.g., marital conflict, parent psychopathology, parents' negative emotionality), and parenting risk factors (e.g., low parental involvement) predict maltreatment (Azar, 2002; Belsky, 1993; Jaffee, in press).

Limitations

Our findings on corporal punishment, based on our United Kingdom sample of 5-year-old twins, are likely to generalize to other Western developed countries because they replicate research conducted with a U.S. sample of adult twins and their parents, who provided retrospective reports of the twins' experiences of childhood corporal punishment (Wade & Kendler, 2000). Nevertheless, the results of this study must be understood within the confines of its methodology.

First, unidirectional models of parent–child relations, be they models of parent effects or child effects, cannot demonstrate the degree to which parents and children mutually influence one another over time (Caspi & Moffitt, 1995; Patterson, DeBaryshe, & Ramsey, 1989). In all likelihood, children's difficult and coercive behavior elicits punitive responses from adults, which, in turn, exacerbate the child's misbehavior. Although our data showed that genetic factors that influenced children's difficult and coercive behavior also explained why some children were more likely than others to be physically disciplined, we were not able to model the very likely process by which corporal punishment has a reciprocal influence on children's antisocial behavior. Longitudinal data in which punitive discipline and child antisocial behavior are measured repeatedly over time are needed to model such a pattern of reciprocal effects. Such fine-grained temporal assessment of child and parent behavior is a strength of observational studies (e.g., Reid et al., 2002), although researchers interested in child effects on corporal punishment or physical maltreatment per se might be hindered by the prohibitively low base rates of these practices during the observation frame. It is also possible that corporal punishment moderates children's genetic risk for antisocial behavior, although the existence of such gene–environment interactions would not preclude the gene–environment correlation demonstrated in our analyses (Kendler & Eaves, 1986).

Second, although we failed to find that heritable characteristics of children elicited maltreatment from adults, the possibility remains that nonheritable child characteristics provoke abusive episodes. Although the child characteristics that have been identified by researchers as potential elicitors of maltreatment (e.g., disruptive behavior or mental retardation; Kadushin & Martin, 1981) are moderately to highly heritable, heritability is a population estimate that does not reflect any given child's level of genetic risk. For example, in their study of adoptees, O'Connor et al. (1998) noted that parents reacted negatively to any child who engaged in coercive and difficult behavior and not only to those who were also at genetic risk.

Third, although environmental factors accounted for most of the variation in corporal punishment and physical maltreatment, genetic influences on the former, but not the latter, were significantly different from zero. On the basis of this finding, we concluded that heritable characteristics of children (specifically, their antisocial behavior) may provoke corporal punishment but are less likely to provoke physical maltreatment. We must qualify this conclusion in two ways. First, the heritability of maltreatment was .07. Power in our sample to detect a heritability of this magnitude was relatively poor. Thus, our finding that corporal punishment was genetically mediated but maltreatment was not may have been due to poor power to detect very small genetic influences on maltreatment. However, we note that had our estimate of genetic influences on maltreatment been as large as the heritability estimate for corporal punishment ($h^2 = .25$), we would have had adequate power to detect it. Second, we note that because the 95% CIs around the heritability estimates for corporal punishment and physical maltreatment overlapped to some degree (see Table 1), these estimates were at best marginally different from one another.

Fourth, because our group of maltreated children was small in number and because physical maltreatment was the only type of maltreatment that was formally assessed, it was not possible to compare subtypes of maltreatment or to compare groups according to severity, chronicity, or precise developmental period of maltreatment, although all cases were necessarily confined to the

infancy–toddlerhood and preschool years (Barnett, Manly, & Cicchetti, 1993). Whether some subtypes of maltreatment are more heritable than others is an empirical question that we could not address, although there is little theoretical rationale to suggest differential heritability.

Fifth, although our measures of corporal punishment and maltreatment have shown good interreporter agreement in other samples, in our sample they came from only the mother. Ideally, our results should be replicated in studies that use independent ratings of corporal punishment and maltreatment from other sources. On the one hand, the possibility that mothers concealed instances of corporal punishment or maltreatment would have exerted a conservative effect on our findings by causing us to misclassify maltreated children as nonmaltreated or children who were physically disciplined as not physically disciplined (although most children in the sample were physically disciplined at some point in their first 5 years). On the other hand, it is possible that mothers' concealment of maltreatment in cases in which either one or both twins had been maltreated may have artifactually inflated the estimate of shared environmental influence on maltreatment (by making most twins in the sample concordant for maltreatment or for nonmaltreatment). That said, strenuous efforts were made to enhance mothers' comfort in reporting instances of maltreatment, the maltreatment protocol we used has been validated in other samples, and the prevalence rates of maltreatment in our sample match those in other epidemiological samples, including ones in which a different maltreatment measure was used. Thus, it is unlikely that mothers concealed maltreatment for a great many cases.

Sixth, further research is necessary to determine whether findings from studies of twins generalize to studies of singletons. However, the rates of maltreatment and corporal punishment found in our sample of twins are similar to those found in singleton samples, and studies of children's antisocial behavior have shown that rates do not differ in twin and singleton samples (Simonoff et al., 1997; van den Oord, Koot, Boomsma, Verhulst, & Orleveke, 1995). In addition, genetically sensitive designs that include nontwin kinship data may provide more accurate estimates of shared environmental effects.

Conclusion

Children who are physically punished and children who are maltreated are at risk for antisocial behavior in childhood and adulthood. Our findings minimize the possibility that children who are the victims of maltreatment provoke abusive incidents as a function of their difficult and coercive behavior, particularly when that behavior is strongly genetically influenced. Difficult children may provoke corporal punishment, but the factors causing child abuse are more likely to be found within the family environment or the adult abuser.

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Call for Nominations

The Publications and Communications (P&C) Board has opened nominations for the editorships of ***Clinician's Research Digest, Emotion, JEP: Learning, Memory, and Cognition, Professional Psychology: Research and Practice,*** and ***Psychology, Public Policy, and Law*** for the years 2007–2012. Elizabeth M. Altmaier, PhD; Richard J. Davidson, PhD, and Klaus R. Scherer, PhD; Thomas O. Nelson, PhD; Mary Beth Kenkel, PhD; and Jane Goodman-Delahunty, PhD, respectively, are the incumbent editors.

Candidates should be members of APA and should be available to start receiving manuscripts in early 2006 to prepare for issues published in 2007. Please note that the P&C Board encourages participation by members of underrepresented groups in the publication process and would particularly welcome such nominees. Self-nominations also are encouraged.

Search chairs have been appointed as follows:

- ***Clinician's Research Digest:*** William C. Howell, PhD
- ***Emotion:*** David C. Funder, PhD
- ***JEP: Learning, Memory, and Cognition:*** Linda P. Spear, PhD, and Peter Ornstein, PhD
- ***Professional Psychology:*** Susan H. McDaniel, PhD, and J. Gilbert Benedict, PhD
- ***Psychology, Public Policy, and Law:*** Mark Appelbaum, PhD, and Gary R. VandenBos, PhD

Candidates should be nominated by accessing APA's EditorQuest site on the Web. Using your Web browser, go to http://editorquest.apa.org. On the Home menu on the left, find Guests. Next, click on the link "Submit a Nomination," enter your nominee's information, and click "Submit."

Prepared statements of one page or less in support of a nominee can also be submitted by e-mail to Karen Sellman, P&C Board Search Liaison, at ksellman@apa.org.

The deadline for accepting nominations is **December 10, 2004,** when reviews will begin.