



Published in final edited form as:

*Twin Res Hum Genet.* 2007 February ; 10(1): 84–95.

## The Early Growth and Development Study: A Prospective Adoption Design

Leslie D. Leve<sup>1,2</sup>, Jenae M. Neiderhiser<sup>3</sup>, Xiaojia Ge<sup>4</sup>, Laura V. Scaramella<sup>5</sup>, Rand D. Conger<sup>4</sup>, John B. Reid<sup>2</sup>, Daniel S. Shaw<sup>6</sup>, and David Reiss<sup>3</sup>

<sup>2</sup>Oregon Social Learning Center, 10 Shelton McMurphey Blvd., Eugene, OR 97401-4928, USA

<sup>3</sup>Center for Family Research, George Washington University, 2300 K Street, N.W., 3rd Floor, Washington, DC 20037, USA

<sup>4</sup>Department of Human and Community Development, University of California, 202 Cousteau Place, Suite 175, Davis, CA 95616, USA

<sup>5</sup>University of New Orleans, Department of Psychology, 2001 Geology and Psychology Building, New Orleans, LA 70148, USA

<sup>6</sup>University of Pittsburgh, Department of Psychology, 4422 Sennott Square, Pittsburgh, PA 15260, USA

### Abstract

The Early Growth and Development Study is a prospective adoption study of birth parents, adoptive parents, and adopted children ( $N = 350$  triads) that was initiated in 2003. The primary study aims are to examine how family processes mediate or moderate the expression of genetic influences in order to aid in the identification of specific family processes that could serve as malleable targets for intervention. Participants in the study were recruited following the birth of the child through adoption agencies located throughout the United States. Assessments occur at 6-month intervals until child age 3 years. Data collection includes the following primary constructs: infant/toddler temperament, social behavior, and health; birth and adoptive parent personality characteristics, psychopathology, competence, stress, and substance use; adoptive parenting and marital relations; and prenatal exposure to drugs and maternal stress. Preliminary analyses suggest the representativeness of the sample and minimal confounding effects of current trends in adoption practices, including openness and selective placement. Future plans are described.

### Keywords

adoption design; genetic; infant; parenting; environment

### Background

Longitudinal and cross-sectional studies have shown that heritable child characteristics influence parents' behavior towards their children (Dunn et al., 1986; Reiss et al., 2000). For

---

<sup>1</sup>Corresponding author. Phone: 541-485-2711. Fax: 541-485-7087. lesliel@oslc.org..

example, heritable hostile behavior in adolescent adoptees has been shown to evoke harsh disciplinary practices in adoptive parents (Ge et al., 1996). Evocative or environmentally mediated effects have also been found to be prominent in the preschool and school entry periods (Deater-Deckard, 2000; Deater-Deckard & O'Connor, 2000). In addition, family context and parenting process play a central role in the *moderation* of genetic influences on child behavior. Large Genotype x Environment (G×E) interaction effects have been found for the development of conduct disorder and aggression in adolescence, antisocial personality disorder in adults, and depression in women. Such G×E interactions are likely present in early childhood, when child behavior has proven to be amenable to intervention (Olds et al., 2005); however, adoption studies prospectively examining social processes during this period are rare, with the current study and the Colorado Adoption Project (Plomin & DeFries, 1985) being the only such studies to date.

In addition, most data on evocative influences are derived from twin studies. Because twin offspring share 50% of their individual difference genes with each parent, it is difficult to ascertain from twin studies whether evocative effects of heritable features in the child have comparable effects in caretakers who do not share the same genes. The adoption design is a powerful method for estimating these effects because adoption is a natural experiment in which children are reared in families where they are genetically unrelated to their caretakers (Haugaard & Hazan, 2003). In the adoption design, similarities between birth parents and their child who has been placed with an adoptive family suggest genetic influences (due to shared genes and a lack of shared rearing environments). Similarities between adoptive parents and adopted children likely reflect environmental processes (due to shared rearing environments and the lack of shared genes).

## Overview of Current Study

This report describes the Early Growth and Development Study (EGDS), a prospective adoption study designed to examine specific features of family relationships that mediate or moderate the expression of genetic influences as they appear in infancy and subsequently unfold later in development. The investigation of G×E interaction effects and genotype–environment (GE) correlations can provide crucial information about malleable environmental processes that might reduce adverse genetic risk. Thus, a second goal of the EGDS is to systematically identify specific family processes and maladaptive conditions that could serve as malleable targets for intervention. The study includes 350 adoption triads consisting of the child, the child's adoptive parents, and the child's birth parents. Assessments occurred during the infancy and toddler periods. By focusing on family processes beginning in infancy, the EGDS provides a unique opportunity to detect GE processes when first expressed.

## Study Hypotheses and Aims

The conceptual model for the EGDS is based on the following hypotheses: (a) adoptive parenting behaviors are influenced by contextual factors (e.g., parental psychopathology, marital conflict, and perceived economic distress), (b) the contextual factors moderate genetic influences on child behavior, (c) adoptive parenting behaviors moderate and

partially mediate genetic influences on child behavior, (d) child characteristics and adoptive parenting behavior show change and continuity across time points, and (e) the relationships described above hold when potential violations of the adoption design assumptions are controlled (i.e., selective placement, intrauterine exposure, and openness in adoption). Within this model, we hypothesize specific mediating and moderating mechanisms on adjustment along three developmental pathways: externalizing behavior, internalizing behavior, and social competence.

There are three primary aims for this study. Aim 1 is to examine specific parenting processes that *mediate* the expression of genetic influences on children's internalizing behavior, externalizing behavior, and social competence. We hypothesize that genetically influenced child behavior will evoke specific parenting practices (GE correlation), that these parenting practices will amplify genetically influenced child behavior, and that this reciprocal process will affect children's psychosocial well-being. Aim 2 is to examine specific parenting processes and contextual factors that *moderate* genetic influences on internalizing behavior, externalizing behavior, and social competence. We hypothesize that specific parenting behaviors (e.g., harsh or noncontingent responses to child aversive behaviors) and contextual factors (e.g., adoptive parent psychopathology) will moderate genetic risk and protective influences on early childhood internalizing behavior, externalizing behavior, and social competence (G×E interaction) and amplify child outcomes over time. Aim 3 is to identify the *mechanisms of G×E interaction*. We focus on mechanisms in order to examine how, when, and why G×E interactions occur. We hypothesize that G×E interactions can be explained by their effects on the reciprocal, genetically-influenced processes between parent and child. Specifically, *child evocative G×E interactions* are indicated when heritable characteristics of the child evoke more adverse or more favorable parental response in some types of family environments but not in others, and *child sensitivity G×E interactions* are indicated when heritable characteristics make the child more sensitive to differences between favorable and adverse family environments.

One illustration of our model is shown in Figure 1: our hypothesis that adoptive parent's intrusive parenting responses will moderate and partially mediate genetic influences on children's anxious behavior in the context of adoptive parent anxiety symptoms, exacerbating child anxiety symptoms over time. The EGDS design is also highly relevant for furthering the understanding of ameliorative and protective processes. For example, supportive environmental conditions can help offset genetic risk, and protective genetic characteristics can buffer against harsh environmental conditions. EGDS includes a focus on both risk and protective processes.

## Recruitment Methods

The EGDS recruitment procedures were designed to accomplish the following: (1) to reduce the likelihood of recruiting only one member of the adoption triad; (2) to minimize potential ethical concerns by not initiating contact until after the period of revocation; (3) to minimize the probability that participation in the study would cause information to be transferred across participants, including adoption agencies; (4) to recruit a sample that would contain

ethnic diversity and varying levels of adoption openness (contact and knowledge between birth and adoptive families); and (5) to recruit a large subsample of birth fathers. This complicated recruitment strategy entailed the collaboration of three recruitment sites: Mid-Atlantic (George Washington University), West/Southwest (University of California, Davis), and Pacific Northwest (Oregon Social Learning Center).

Recruitment efforts began in Spring 2003 with the recruitment of adoption agencies into the study ( $N = 33$  agencies in 10 states). The agencies reflected the full range of U.S. adoption agencies: public, private, religious, secular, those favoring more open adoptions, and those favoring more closed adoptions. Because adoption agencies often work in multiple states, the EGDS participants currently reside in 43 states. Each adoption agency appointed a liaison from their organization to perform the initial stages of recruitment into the study. Liaisons received recruitment training by the EGDS staff, and agencies were provided an honorarium for their efforts assisting with recruitment.

### **Inclusion criteria**

Agency liaisons identified participants who completed an adoption plan through their agency and met the study's eligibility criteria: (a) the adoption placement was domestic, (b) the baby was placed within 3 months postpartum, (c) the baby was placed with a nonrelative adoptive family, (d) the baby had no known major medical conditions such as extreme prematurity or extensive medical surgeries, and (e) the birth and adoptive parents were able to read or understand English at the eighth-grade level. All types of adoptive families were eligible for study enrollment (e.g., same-sex parents, single parents, and hearing-impaired parents). A total of 1796 triads met the study criteria. A flow chart of the recruitment procedures is illustrated in Figure 2 with the left bolded column indicating the path to a successfully recruited adoption triad.

### **Initial recruitment by agency liaison**

Once eligibility criteria were met, approximately 4 weeks postplacement, the agency liaison mailed a letter on agency letterhead describing the study to each eligible adoptive family. A study brochure and a postcard were included for the adoptive family to return if they did not wish to be contacted. Two weeks after the mailing, liaisons called the birth mothers linked to the adoptive families that did not return a postcard (82% of the adoptive family letters mailed). During the telephone call with the birth mother, the liaison briefly described the study and asked for permission to have a recruiter from the study contact her directly. When the birth mother gave permission for study contact, the liaison provided the telephone number of the birth mother to the EGDS birth parent recruiter. The project employs separate birth parent and adoptive family recruiters to ensure that project staff does not transfer information between members of the adoption triad. We maintain this separation through all stages of the study, including assessment.

### **Recruitment of birth mothers by project staff**

Once a birth mother had consented to being contacted (79% of the time), a birth parent recruiter called her and attempted to recruit her into the study. If the birth mother agreed to participate (91%), she was sent an informed consent form and additional study information.

One week later, the recruiter called the birth mother to review the consent form and answer questions. Once the birth mother returned a signed consent form via postage-paid mail, she was considered an active study participant.

### **Recruitment of adoptive families by project staff**

After recruiting the birth mother, an adoptive family recruiter attempted to recruit the adoptive family using contact information provided by the agency. The adoptive family recruiter contacted the adoptive family by telephone, reminded the family of the letter sent previously, and provided detailed information about the study and about participation. If the adoptive parents agreed to participate (66%), they were sent informed consent forms and additional study information. Like birth mothers, adoptive parents were considered recruited once they returned a signed informed consent form.

At any point, if the birth mother or adoptive family declined participation or was unable to be contacted, recruitment efforts for that adoption triad ceased. However, once an individual had consented to participate, that individual continued as a participant regardless of the status of the other members of the triad. Such participants are not considered as part of our sample of 350 adoption triads and are not included in analyses examining our primary hypotheses that require linked adoptive parent and birth parent data.

### **Recruitment of birth fathers by project staff**

Once the birth mother and adoptive parents were recruited, project staff attempted to recruit the birth father. Most adoption studies incorporate information about birth fathers only from hospital records or similar reports. Thus, genetic contributions to child behavior in previous adoption studies have been estimated primarily from knowledge of only 50% of the genetically transmitted characteristics (i.e., birth mother characteristics only). The EGDS has the largest sample of directly studied birth fathers in an adoption study and is the only study to assess birth fathers longitudinally; we have recruited and assessed birth fathers in 33% of our participating triads ( $n = 115$ ). Project staff members attempted to recruit the birth father using the procedures outlined in the birth mother recruitment section. Confidentiality of participation between birth mother and birth father was maintained such that neither the agency nor project staff shared information about birth parent study participation between participants. If the agency liaison did not know or could not reach the birth father, a project staff member asked the birth mother if she was willing to answer some questions about the birth father to help the study locate him and invite him to participate. In such cases, the birth mother was asked about the birth father's identity, her ability to contact him, and any personal concerns about potential harm from the birth father should she provide the study with his contact information. If a birth mother did not perceive harm and agreed to provide contact information, she completed a consent form releasing his information to the study.

As is shown in Figure 2, project recruitment staff had low rates of declines (2% of birth mothers, 19% of adoptive families, and 11% of birth fathers). Most nonparticipants resulted from the inability of the agency or the project to locate and contact a potential participant. No systematic sampling biases were detected in recruitment, as is detailed below.

## Sample Description

The EGDS sample includes 350 triads: 350 adopted children, 350 sets of adoptive parents, 350 birth mothers, and 115 birth fathers. The mean age of the adoption placement was 3 days ( $SD = 5$  days). Adoptive children's birth dates ranged from January 2003 to January 2006. Demographic information regarding parent age, race, education, income, and the number of individuals living in the home at the time of the adoption placement is provided in Table 1. Adoptive families had been married an average of 11.8 years ( $SD = 5.4$  years) and 31% of the adoptive families had at least one additional child in the home (*median* age of additional children = 4.6 years, *range* = newborn to 21 years). The majority of the time (94%), the additional children were not biologically related to the study child; 6% of the time they were a full sibling to the study child.

As is indicated by these demographic statistics, the discrepancy in sociodemographic characteristics often found between birth and adoptive parents (DeFries, Plomin, & Fulker, 1994) was corroborated in EGDS. This suggests the utility of adoption as an intervention on the sociodemographic environments of young children. It also indicates potential restriction of range in the environment, as has been noted in prior reviews of the adoption design (Stoolmiller, 1999). However, a recent systematic test of range restriction biases has shown negligible effects on estimates of heritability and the environment, even when range restriction was present (McGue et al., 2006). Further, the percent of adoptive parents in the EGDS sample with clinical-range anxiety and depression (Beck Anxiety Inventory [Beck et al., 1988] and the Beck Depression Inventory [Beck et al., 1988]), psychopathology/problems (self-report and partner report), and divorce/single-parent status since the birth of the child show adequate variability (Table 2). For comparison, we include similar statistics from several of Cadoret's adoption studies that have detected substantial G×E interactions in adolescent and adult adoptees (Cadoret et al., 1990, 1996). Notably, the rates of problems in the EGDS adoptive families are substantial and are quite similar to the Cadoret samples, despite the younger age of our adoptive parents and the briefer duration of their marriages. For example, our 9% divorce/single parent rate assessed at child age 18-months can be expected to increase over time. In addition, our rates of anxiety and depression are comparable to other adult populations (Greenberg & Beck, 1989). This variability in adoptive family environment will facilitate the study's ability to detect environmental main effects and interactions as required to test the study hypotheses.

## Data Collection

Measurement for the EGDS has been guided by three principles: adherence to a theoretical model guiding the domains of assessment between parents and children, adoptive family completion of three primary assessments to allow for curvilinear estimates of change, and utilization of a multimethod, multiagent assessment strategy.

## Guiding theoretical model

Our theoretical model rested on research indicating the family process predictors of and continuities within three lifecourse developmental pathways: internalizing behavior, externalizing behavior, and social competence. Lifecourse development in each of these



pathways is well supported by existing genetic and social data (e.g., Caspi et al., 1995; Eisenberg et al., 2003; Gilliom & Shaw, 2004). To select phenotypes (and subsequent measures) to focus on in our conceptual model, we relied on three types of studies: *adoption studies* to identify phenotypes that are known to be linked between birth parent and adopted child and to also be influenced by the environment (e.g., Ge et al., 1996); *twin and sibling studies* to identify phenotypes that have known genetic and environmental influences (e.g., Petrill et al., 2006); and *lifecourse studies* to identify how a phenotype might change or evolve across development (e.g., Caspi & Roberts, 2001). Individually, these approaches have limitations as guiding methodologies. For example, the knowledge base from adoption studies is quite small, twin-and-sibling studies generally do not permit a comparison of phenotypes between generations, and lifecourse studies without a genetically sensitive component cannot distinguish between phenotypic stability due to environmental versus genetic influences. Considered together, however, these three lines of work permitted us to develop data-based hypotheses about probable birth parent–adopted child phenotypic similarities and likely environmental influences on these genetically influenced phenotypes. For example, converging evidence from twin, adoption, and lifecourse studies has pointed to birth parent anxiety and child fearful temperament, birth parent antisocial behavior and child impulsivity, and birth parent sociability and child positive affect as three sets of phenotypes that are genetically linked across generations and for which there are known environmental influences. We applied this guiding methodology to aid in the selection of the developmental pathways under investigation (externalizing, internalizing and social competence), the specific domains of functioning within each pathway (e.g., anxiety, depression, antisocial behavior, and sociability).

### Overview of assessment

The EGDS assessment includes questionnaires, in-person interviews, telephone interviews, and standardized testing for birth and adoptive parents and observational interactions for adoptive families. Medical records for birth parents and adopted children are also collected. The interviews include interviewer-administered questions, which create a context whereby the interviewer can establish rapport with the participant, and computer-assisted personal interviews (CAPI) that are completed privately by participants to facilitate confidentially and honest responses. Birth parents are assessed in person at 3–6 months and 18 months postpartum and via telephone at 12, 22, 30, and 42 months. Adoptive families are assessed in person at 9, 18, and 27 months and via telephone at 6, 12, 22, and 36 months. In-person assessments last approximately 2.5 hr, and telephone interviews last approximately 15 min. A listing of the measures administered is presented in Table 3.

### In-person assessments

Birth parent in-person interviews are conducted in a location convenient for the participant, most often at home. Both interviews include CAPI questions, interviewer-administered questions, and mailed questionnaires (completed prior to the interview). During first interview (3–6 months), birth mothers complete a pregnancy history calendar about their activities and events during their pregnancy by each interval/trimester. Once this calendar of salient events is completed, birth mothers report about drug use and other behaviors during pregnancy via CAPI. The second interview (18 months) is similar to the first interview with

a few exceptions. The most significant additions to the second in-person assessment are the collection of detailed diagnostics using the Composite International Diagnostic Interview (Kessler & Üstün, 2004) and the assessment of intelligence using two subscales from the Wechsler Adult Intelligence Scale (Wechsler, 1997). Birth parents also complete a CAPI version of the antisocial personality and conduct disorder sections from the Diagnostic Interview Schedule (Robins et al., 2000).

The three adoptive family in-person assessments (at 9, 18, and 27 months) are conducted in the family's home. Assessments consist of questionnaires sent to the adoptive parents for completion prior to the interview, CAPI questions completed during the visit, and videotaped interactions of the child, of each parent with the child, and of the parents together. The interactive tasks are designed to measure child behavior, temperament, and parenting using a set of developmentally appropriate stimuli.

### Telephone interviews

Telephone interviews are coordinated to occur in between the in-person assessments as a means of maintaining contact and rapport with participants. The four birth parent telephone interviews focus primarily on general well-being and on the ongoing relationship with the adoptive family and the adoption agency. In addition, to improve estimates of genetic transmission of behavior by increasing information about nonparticipating birth fathers, each birth mother reports on the birth father's characteristics. We found birth mothers to be accurate reporters on birth fathers, especially on his mental health status, with correlations of .35–.36 for depression and anxiety, .23–.41 for antisocial personality and legal problems, and .35 for drug use problems. It is important to note that these correlations also indicate that birth mothers are able to discriminate between a birth father's mental health problems and his drug use problems, with higher correlations within constructs than across. This is consistent with previous reports examining the accuracy of spousal reports on one another (e.g., Achenbach et al., 2005; Caspi et al., 2001). The four adoptive family telephone interviews focus primarily on the ongoing relationship with the birth parents and the agency, on general well-being, and on the adopted child's daily behavior and parenting.

### Statistical Power

We modeled several alternative values based on commonly observed genetic and environmental effects to examine our power to test the primary hypotheses with our sample of 350 triads. We estimated a 92% retention rate based on our current retention rates for the second assessment (99% for adoptive families, 90% for birth mothers, and 89% for birth fathers). Most of the core hypotheses can utilize birth parent data from the first assessment to measure genetic influences if birth parent data from subsequent waves are missing. Our power analyses were based on converging practices (Cohen, 1988) and on state-of-art results (MacCallum et al., 1996). We sought to determine whether the sample of 350 triads ( $N = 322$  when a 92% retention rate is assumed) is sufficient for detecting significant genetic and environmental main effects, significant G×E interaction effects, and model fit in SEM. We used the commonly reported genetic effects for the constructs under investigation (range = .10–.50) and findings of birth parents' effects on adolescent adoptees ( $\beta = .31$  and .42; Ge et al., 1996; O'Connor et al., 1998). Power analysis results suggested that a sample of 322



triads would provide power well above .90 for detecting genetic and environmental main effects, power of .50–.98 for detecting G×E interaction effects, and power of .78–.93 for model testing in SEM, suggesting sufficient power to test the study hypotheses.

## Preliminary Analyses

Participant enrollment was completed during spring 2006, and data collection for all study waves is underway. Demographic information has been recorded for all participants (used in the first set of analyses below), and a subsample of 280 triads has completed their first in-person assessment (used in the second set of analyses below). Analyses focus on investigating sample representativeness and investigating adoption practices.

### Sample representativeness

We sought to examine whether the EGDS sample was representative of the population from which it was drawn. To assist with this, each participating adoption agency recorded the education, income, and age of all birth and adoptive parents who met the EGDS inclusion criteria and completed an adoption plan through their agency during the EGDS enrollment period. We compared the demographic information between triads who participated in the EGDS ( $N = 350$  triads) with those of the eligible, nonparticipants ( $N = 1169$  triads available for analysis). As shown in Table 4, only 2 of 11 comparisons reached statistical significance, and they proved trivial in practical terms (i.e., participating adoptive mothers achieved slightly higher educational levels than nonparticipating adoptive mothers, and participating birth fathers were slightly younger than nonparticipating birth fathers). There were no significant demographic differences between birth mothers for whom birth fathers were recruited and birth mothers for whom birth fathers were not recruited. These comparisons suggest the representativeness of the EGDS sample to the population from which it was drawn.

Because our sample was recruited from three different regions, regional differences in sample characteristics were examined. We compared birth mother, birth father, adoptive mother, and adoptive father education level, income, and age by region. Of the 33 comparisons, only three were significant ( $p < .05$ ): adoptive father's education was slightly higher in the Pacific Northwest than in the West/Southwest site or the Mid-Atlantic site and birth mother's household income was slightly higher in the Mid-Atlantic site than the West/Southwest site. The ethnic distribution of participants was also similar across regions. Taken together, these preliminary analyses provide greater confidence of the representativeness of the EGDS sample and the generalizability of study results.

### Adoption practices

The adoption design rests on several assumptions about the separate influences of genetic and environmental influences on child development. For example, once intrauterine factors such as prenatal alcohol and drug consumption, maternal depression and stress, and exposure to environmental toxins have been considered, similarities between the birth parent and adoptive child can be assumed to result from genetic factors. Trends in adoption practices such as selective placement (agency matching of birth and adoptive parent

characteristics) and openness (contact and knowledge between birth and adoptive families) can pose a threat to these assumptions and can bias model estimates. For example, adoptive children might be more likely to resemble their birth parents (inflating genetic estimates) if birth parents are in direct contact with the child. Thus, we examined the variation in two aspects of the adoption process—openness and selective placement—with our preliminary sample of 280 triads and then examined whether systematic variation in these characteristics biased our model estimates.

The level of openness was measured by asking birth mothers and adoptive mothers and fathers to report on the amount of contact and knowledge between them. Responses were categorized into seven discrete categories: very closed (no information about the adoptive parents/birth parents), closed (only general information that the agency provided), mediated (written communication only, conducted through an agency), semi-open (exchange of letters/emails, cards, and pictures but no face-to-face contact), open (visits one to three times per year and communication semiregularly by telephone, mail, or E-mail), quite open (visits about every other month and frequent communication by telephone, mail, or E-mail), and very open (visits at least once monthly and communication several times a month by telephone, mail, or E-mail). The prevalence of each level of openness as rated by birth and adoptive parents is shown in Table 5. Results suggest significant variation in openness across the sample. In addition, birth mothers, adoptive mothers, and adoptive fathers were in strong agreement about the level of openness ( $r = .72-.87$ ).

An openness composite that included birth mother, adoptive mother, and adoptive father report of openness (described above), the level of contact between the birth and adoptive parents (5 scales ranging from 1 [*Never*] to 5 [*Daily*]), and the extent of knowledge about each other (6 scales ranging from 1 [*A lot*] to 4 [*Nothing*]) was constructed ( $\alpha = .85$ ). Preliminary analyses suggest that the number of significant correlations between the openness composite and our birth parent and adoptive family measures approximated levels expected by chance, suggesting negligible impact of openness on model estimates.

To test for selective placement, we correlated birth parent characteristics with adoptive family characteristics that were unlikely to be influenced by evocative effects (e.g., demographic characteristics). No relationship was significant. Thus, systematic selective placement or bias due to the level of openness has not been detected in the EGDS sample, though we will continue to examine such variables as the child matures and the effects of openness may change.

## Future Plans

The current funding supports in-person data collection of the EGDS participants through child age 27-months. These assessments will be completed by April 2008. We will continue to monitor and evaluate the sample representativeness and adoption practices while testing the study's primary hypotheses of the mediating and moderating role of the environment on the expression of genetic influences.

### Hypothesis testing in the current study

Prior to pursuing hypothesis testing, composite indices for each prespecified domain of functioning will be constructed for birth parents to estimate genetic influences, for adoptive parents to estimate parenting and context, and for adoptive children to estimate the behavioral constructs hypothesized in the study aims. In the course of developing our constructs, we will attempt to include observational data, records data, and questionnaire data so that we minimize potential method variance problems. When this is not possible (e.g., when the association between measures for the same construct is low-to-moderate), we will retain measures in single-agent form. To examine the hypothesized evocative GE correlations, we will first examine associations between birth parent characteristics (e.g., sociability) and adoptive parenting (e.g., sensitive parenting). A significant association is strong evidence for evocative GE correlation. In the absence of effects of confounding factors, this association should occur only when the child serves as a mediator. Further analysis is necessary to assess whether measured characteristics of the child mediate the birth parent–adoptive parent association. We will use SEM to trace these mediated effects under the criteria set by Baron and Kenny (1986).

Multiple regression and SEM will be employed to examine our G×E hypotheses. We will examine the G×E interaction between parental response to the child and birth parent characteristics in predicting adopted child outcomes. A significant statistical interaction between adoptive parenting and birth parent characteristics suggests that the expression of genetic characteristic in the child is amplified or alleviated according to adoptive parenting behaviors.

### Additional hypotheses requiring new data collection

We are also seeking funding to incorporate two additional sets of hypotheses into the EGDS study. In the first, we seek to extend the focus of EGDS by collecting additional data designed to facilitate the disaggregation of the effects of genes, prenatal drug exposure, and postnatal rearing environment by increasing the sample size by 200 triads and collecting DNA from all participants. Prenatal experiences of the child were categorized as potential confounds in EGDS. In this first extension, the focus is on how the rearing environment enhances or reduces risk to children engendered by drug use by birth parents and on estimating whether this risk is conferred by genetic or intrauterine mechanisms or an interaction between the two. By adding collection of DNA from all family members and shifting the measurement focus, we will begin to disentangle the effects of genetic risk from the effects of the prenatal and postnatal environments on the development of toddlers. Because this proposed extension is focused on disentangling the effects of prenatal drug exposure from genetic risk and on interactions between specific genes and specific environments, the EGDS sample size of 350 triads does not provide enough power to test these aims. As a result, the first extension seeks to collect data on an additional 200 triads ( $N = 550$ ).

In the second extension, we will explore how genetic and environmental influences on child behavior can be traced through their influences on three early responding systems that undergo substantial maturation during the preschool period: emergent literacy, HPA

functioning, and executive functioning. Each of these systems is influenced by genetic and environmental factors and might thus moderate a child's effect on or sensitivity to the family environment. In addition, each are closely linked to internalizing, externalizing, and social competence. Each system might be a product of environmental moderation processes and might thus provide the first developmental indication of specific environmental effects that moderate genetic influences. We hypothesize that there are G×E interactions on HPA functioning, executive functioning, and emergent literacy and that such environmental moderation affects children's internalizing, externalizing, and socially competent behavior. In each early responding system, we seek to narrow the gap between the moderating variables and the developmental processes on which they exert their influence. Both of these proposed extensions are currently under consideration for future funding.

## Acknowledgments

This project was supported by grant 5 R01 HD 42608 from the National Institute of Child Health and Human Development and the National Institute on Drug Abuse (David Reiss, MD, PI). We are indebted to the late Remi Cadoret for his insightful contributions to the understanding of G×E interaction and for his commitment to the EGDS project from its onset. In addition, we are grateful to participating adoption agency directors and staff, without whom this work would not have been possible. Other key contributors to the project include our project officer, Lisa Freund; our Advisory Board; the lead recruiters, Amy Whitesel, Danielle Guerrero, and David Martin; the site supervisors, Anna Suski, Denise Ford, Laura Kwako, and Roline Milfort; the biostatistics team, Sam Simmens and Karen Jones; and the dozens of other EGDS team members who contributed to recruitment, data collection, and data management efforts. Additional thanks go to Amber Johnson for assistance with the data analyses and to Matthew Rabel for editorial assistance.

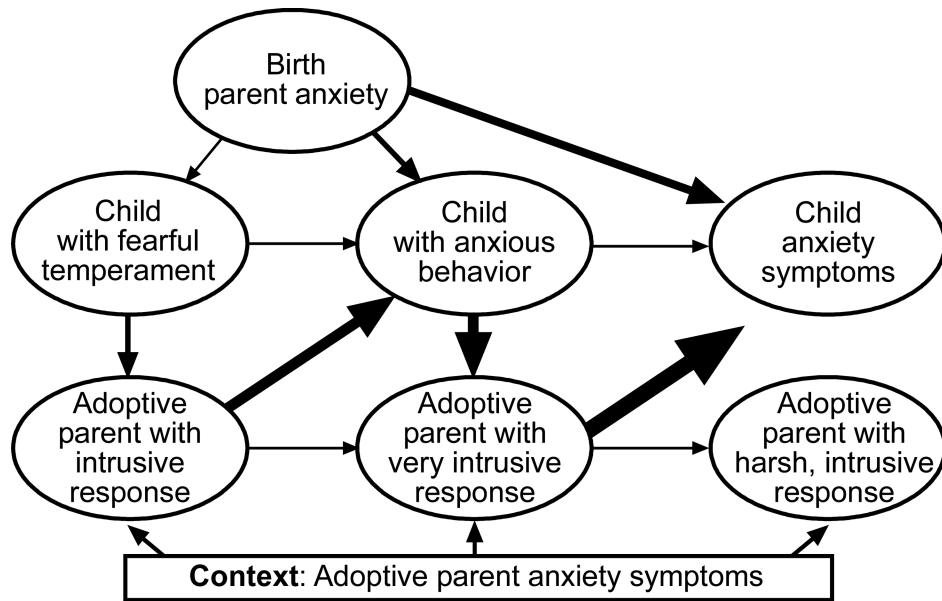
## References

- Achenbach TM, Krukowski RA, Dumenci L, Ivanova MY. Assessment of adult psychopathology: Meta-analyses and implications of cross-informant correlations. *Psychological Bulletin*. 2005; 131:361–382. [PubMed: 15869333]
- Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*. 1986; 51:1173–1182. [PubMed: 3806354]
- Beck AT, Epstein N, Brown G, Steer RA. An inventory for measuring clinical anxiety: Psychometric properties. *Journal of Consulting and Clinical Psychology*. 1988; 56:893–897. [PubMed: 3204199]
- Beck AT, Steer RA, Garbin MG. Psychometric properties of the Beck Depression Inventory: Twenty-five years of evaluation. *Clinical Psychology Review*. 1988; 8:77–100.
- Button TMM, Scourfield J, Neilson M, Purcell S, McGuffin P. Family dysfunction interacts with genes in the causation of antisocial symptoms. *Behavior Genetics*. 2005; 35:115–120. [PubMed: 15685425]
- Cadoret RJ. Genotype–environment interaction in antisocial behavior. *Psychological Medicine*. 1982; 12:235–239. [PubMed: 7100347]
- Cadoret RJ, Cain CA. Genotype–environmental interaction in antisocial behavior. *Psychological Medicine*. 1981; 12:235–239. [PubMed: 7100347]
- Cadoret RJ, Cain CA, Crowe RR. Evidence for gene–environment interaction in the development of adolescent antisocial behavior. *Behavior Genetics*. 1983; 13:301–310. [PubMed: 6615382]
- Cadoret RJ, Troughton E, Bagford J, Woodworth G. Genetic and environmental factors in adoptee antisocial personality. *European Archives of Psychiatry and Neurological Sciences*. 1990; 239:231–240. [PubMed: 2138547]
- Cadoret RJ, Winokur G, Langbehn D, Troughton E, Yates WR, Stewart MA. Depression spectrum disease. I: The role of gene–environment interaction. *American Journal of Psychiatry*. 1996; 153:892–899. [PubMed: 8659611]

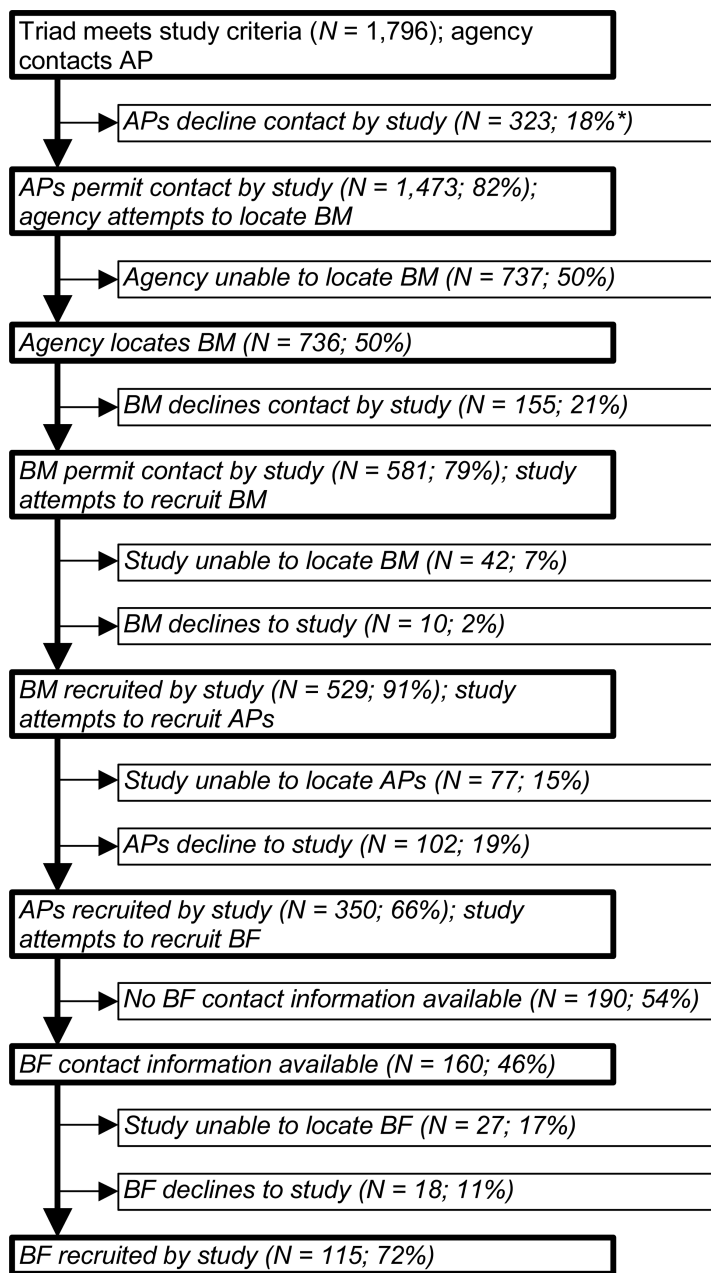
- Cadoret RJ, Yates WR, Troughton E, Woodworth G, Stewart MA. Genetic– environmental interaction in the genesis of aggressivity and conduct disorders. *Archives of General Psychiatry*. 1995; 52:916–924. [PubMed: 7487340]
- Caspi A, Henry B, McGee RO, Moffitt TE, Silva PA. Temperamental origins of child and adolescent behavior problems: From age 3 to age 15. *Child Development*. 1995; 66:55–68. [PubMed: 7497829]
- Caspi A, Roberts BW. Personality development across the life course: The argument for change and continuity. *Psychological Inquiry*. 2001; 12(2):49–66.
- Caspi A, Taylor A, Smart M, Jackson J, Tagami S, Moffitt TE. Can women provide reliable information about their children's fathers? Cross-informant agreement about men's lifetime antisocial behaviour. *Journal of Child Psychology and Psychiatry and Allied Disciplines*. 2001; 42:915–920.
- Cohen, J. *Statistical power analysis for the behavioral sciences*. 2nd ed.. Erlbaum; Hillsdale, NJ: 1988.
- Deater-Deckard K. Parenting and child behavioral adjustment in early childhood: A quantitative genetic approach to studying family processes. *Child Development*. 2000; 71:468–484. [PubMed: 10834478]
- Deater-Deckard K, O'Connor TG. Parent–child mutuality in early childhood: Two behavioral genetic studies. *Developmental Psychology*. 2000; 36:561–570. [PubMed: 10976597]
- DeFries, JC.; Plomin, R.; Fulker, DW. *Nature & nurture during middle childhood*. Blackwell; Cambridge, MA: 1994.
- Dunn J, Plomin R, Daniels D. Consistency and change in mothers' behavior towards young siblings. *Child Development*. 1986; 57:348–356. [PubMed: 3956317]
- Eisenberg N, Valiente C, Morris AS, Fabes RA, Cumberland A, Reiser M, et al. Longitudinal relations among parental emotional expressivity, children's regulation, and quality of socioemotional functioning. *Developmental Psychology*. 2003; 39:3–19. [PubMed: 12518805]
- Ge X, Conger RD, Cadoret RJ, Neiderhiser JM, Yates W, Troughton E, et al. The developmental interface between nature and nurture: A mutual influence model of child antisocial behavior and parent behaviors. *Developmental Psychology*. 1996; 32:574–589.
- Gilliom M, Shaw DS. Co-development of externalizing and internalizing problems in early childhood. *Development and Psychopathology*. 2004; 16:313–334. [PubMed: 15487598]
- Greenberg MS, Beck AT. Depression versus anxiety: A test of the content-specificity hypothesis. *Journal of Abnormal Psychology*. 1989; 98:9–13. [PubMed: 2708648]
- Haugaard JJ, Hazan C. Adoption as a natural experiment. *Development and Psychopathology*. 2003; 15:909–926. [PubMed: 14984132]
- Kessler RC, Üstün TB. The World Mental Health (WMH) Survey Initiative version of the World Health Organization (WHO) Composite International Diagnostic Interview (CIDI). *International Journal of Methods in Psychiatric Research*. 2004; 13:93–121. [PubMed: 15297906]
- MacCallum RC, Browne MW, Sugawara HM. Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods*. 1996; 1:130–149.
- McGue M, Keyes M, Sharma A, Elkins I, Legrand L, Johnson, et al. The environment of adopted and non-adopted youth: Evidence on range restriction from the sibling interaction and behavior study (SIBS). 2006 Manuscript submitted for publication.
- O'Connor TG, Deater-Deckard K, Fulker D, Rutter M, Plomin R. Genotype–environment correlations in late childhood and early adolescence: Antisocial behavioral problems and coercive parenting. *Developmental Psychology*. 1998; 34:970–981. [PubMed: 9779743]
- Olds, DL.; Robinson, J.; Song, N.; Little, C.; Hill, P. *Reducing risks for mental disorders during the first five years of life: A review of the literature*. Substance Abuse and Mental Health Services Administration; Rockville, MD: 2005.
- Petrill SA, Deater-Deckard K, Thompson LA, DeThorne LS, Schatschneider C. Reading skills in early readers: Genetic and shared environmental influences. *Journal of Learning Disabilities*. 2006; 39(1):48–55. [PubMed: 16512082]
- Plomin, R.; DeFries, JC. *Origins of individual differences in infancy: The Colorado Adoption Project*. Academic Press; Orlando, FL: 1985.

- Reiss, D.; Neiderhiser, J.; Hetherington, EM.; Plomin, R. *The Relationship Code: Deciphering genetic and social patterns in adolescent development*. Harvard University Press; Cambridge, MA: 2000.
- Robins, LN.; Cottler, LB.; Bucholz, KK.; Compton, WM.; North, CS.; Rourke, KM. *Diagnostic Interview Schedule for the DSM-IV (DIS-IV)*. Washington University School of Medicine; St. Louis, MO: 2000.
- Stoolmiller M. Implications of the restricted range of family environments for estimates of heritability and nonshared environment in behavior-genetic adoption studies. *Psychological Bulletin*. 1999; 125:392–409. [PubMed: 10414224]
- Wechsler, D. *Wechsler Adult Intelligence Scale*. 3rd ed.. Psychological; San Antonio, TX: 1997.





**Figure 1.** Illustration of environmentally mediated and moderated influences on children's expression of anxious behavior.



\* Percentiles for each box correspond to the proportion relative to the bolded box above it.

**Figure 2.**  
Recruitment procedures and rates.

**Table 1**

## Demographics for Birth Parents and Adoptive Parents

<b>Variable</b>	<b>Birth mother</b>	<b>Birth father</b>	<b>Adoptive mother</b>	<b>Adoptive father</b>
Mean age (in years)	23.84	25.61	36.98	37.82
Race (%)				
Caucasian	75	79	91	91
African-American	9	5	4	6
Asian	2	1	1	1
Multi-ethnic	6	8	2	0
Other	8	7	2	2
Mean educational level	5	5	9	9
Median annual household income	<\$20K	<\$20K	\$100K+	\$100K+
Mean number of individuals in home	3.7	3.5	3.7	3.7

*Note.* Education: 1 (< 8th grade), 2 (Completed 8th grade), 3 (Completed 12th grade), 4 (Some trade school), 5 (Completed trade school), 6 (Some junior college), 7 (Completed junior college), 8 (Some college), 9 (Completed college), 10 (Some professional/graduate school), 11 (Completed professional/graduate school).

**Table 2**

## Range of Variation in Adoptive Parent Characteristics

Characteristic	Adoptive family	
	EGDS	Cadoret (1990, 1996)
Anxiety	24%	25%
Depression	13%	30%
Total psychopathology/problems	66%	43%
Divorce/single-parent home	9%	12%

Table 3

## List of Study Measures

Name of measure	Mode of collection <sup>1</sup>	Assessment (in child age months) <sup>2</sup>				
		3	9	18	27	Phone interviews (6, 12, 22, 30, 36, & 42)
Birth parent (genetic) & adoptive parent (postnatal environment) risk factors						
<i>Drug use and psychopathology</i>						
Composite International Diagnostic Instrument	CAPI, I			BP		
CIDI Short Form – symptoms	CAPI	BP		AP	AP	
Tobacco use frequency <sup>3</sup>	CAPI	BP		AP		
Beck Anxiety Inventory	CAPI, M	BP	AP	BP, AP	AP	
Beck Depression Inventory	CAPI, M	BP	AP	BP, AP	AP	
Diagnostic Interview Schedule (DIS) – antisocial personality & conduct disorder components	CAPI			BP		
Personality Diagnostic Questionnaire	M		AP	AP		
Elliott Social Behavior Questionnaire	M	BP		BP		
Public Records	Records			BP		
Brief Depression/Anxiety Screeners & Police Contact <sup>3</sup>	T			BP, AP		BP, AP
Family History Research Diagnostic Criteria	CAPI	BP	AP			
<i>Temperament, personality, and health</i>						
Temperament & Character Inventory	M	BP	AP			
Adult Self-Perceived Competence	CAPI, M	BP	AP			
General Life Satisfaction Questionnaire	M	BP	AP	BP	AP	
SF-36 Health	CAPI	BP	AP	BP, AP		
Adult Temperament Questionnaire	M			BP		
Life Orientation Test	CAPI					BP
Interviewer Impressions <sup>3</sup>	O	BP	AP	BP, AP	AP	BP, AP
<i>Executive functioning and intelligence</i>						
WAIS : Information & Picture Completion	I			BP		
Computerized Stroop Task	I			BP		
Prenatal exposure to drugs						
Pregnancy History Calendar <sup>3,4</sup>	CAPI	BP				
Medical Records	Records	BM				
Postnatal environment						
<i>Parenting</i>						
Handprint & Footprint Tasks <sup>3</sup>	O		AF			
High Chair Task <sup>3</sup>	O		AC			
Waiting Task <sup>3</sup>	O				AC	
Parent-Child Teaching Task <sup>3</sup> (mother & father, separately)	O		AF	AF	AF	

Name of measure	Mode of collection <sup>1</sup>	Assessment (in child age months) <sup>2</sup>				
		3	9	18	27	Phone interviews (6, 12, 22, 30, 36, & 42)
Child Clean-Up Task <sup>3</sup> (mother & father, separately)	O		AF	AF	AF	
Reunion <sup>3</sup>	O		AP	AP	AP	
HOME	I		AP	AP	AP	
Parenting Scale	M		AP	AP	AP	
Parent Daily Report	M, T			AP	AP	AP
Parental Efficacy Questionnaire	M		AP	AP	AP	
Parenting Daily Hassles	M		AP	AP	AP	
Student-Parent Relationship	M				AP	
Interviewer Impressions <sup>3</sup>	O		AP	AP	AP	AP
<i>Marital relationship</i>						
Marital Relationship Questionnaire	CAPI		AP	AP	AP	
Marital Interaction Task	O		AP		AP	
<i>Parent social stress and socioeconomic status</i>						
Negative Life Change Events	M	BP	AP	BP	AP	
Family Financial Questionnaire	M	BP	AP	BP, AP	AP	
Family Demographics <sup>3</sup>	M		AP	AP	AP	
Report of Partner's Demographics/Behavior <sup>3</sup>	CAPI	BP	AP			BP
Therapy Services Use <sup>3</sup>	M				AP	
Adopted child characteristics (questionnaires completed by adoptive mothers and fathers)						
<i>Temperament</i>						
Infant Behavior Questionnaire	M		AP			
Toddler Behavior Questionnaire	M			AP	AP	
Infant Characteristics Questionnaire	M		AP	AP	AP	
Maternal Perception Questionnaire	M		AP	AP	AP	
Home Temperament Task	O		AC	AC	AC	
High Chair Task <sup>3</sup>	O		AC			
WaitingTask <sup>3</sup>	I				AC	
Gift Delay	O				AC	
Handprint & Footprint Tasks <sup>3</sup>	O		AF	AF		
Gentle Arm Restraint	O				AC	
Initial Free Play with Interviewer <sup>3</sup>	O		AP	AP	AP	
Interviewer Impressions <sup>3</sup>	O		AP	AP	AP	AP
<i>Health and functioning</i>						
Sleep Habits	M		AP	AP	AP	
Your Child's Health <sup>3</sup>	M		AP	AP	AP	
<i>Executive functioning and language development</i>						



Name of measure	Mode of collection <sup>1</sup>	Assessment (in child age months) <sup>2</sup>				
		3	9	18	27	Phone interviews (6, 12, 22, 30, 36, & 42)
Stroop Shape Task	I				AC	
Inhibitory Control (from TBQ)	M			AP	AP	
Gift Delay Task	O				AC	
CBCL Language Scale	M				AP	
<i>Toddler outcome</i>						
Child Behavior Checklist	M			AP	AP	
Maternal Perception Questionnaire	M		AP	AP	AP	
Preschool Socioaffective Profile	M				AP	
Clean Up Task (mother & father, separately)	O		AF	AF	AF	
Potential confounds (assessed for all birth and adoptive parents)						
Adoption Process Interview <sup>3</sup>	CAPI	BP	AP	BP, AP	AP	
Adoption Agency Experiences <sup>3</sup>	CAPI, T	BP				AP
Perceptions of Similarities and Differences <sup>3</sup>	T					AP
Adoption Profile <sup>3</sup>		BP	AP			
Opinions about Genetic Inheritance	CAPI	BP	AP			
Birth Parent Contact with Adoptive Parent <sup>3</sup>	T	BP		BP		BP
Adoptive Parent Contact with Birth Parent <sup>3</sup>	T		AP	AP	AP	AP
Birth Parent Current Functioning						
Romantic Relationships	M			BP		
About Your Health <sup>3</sup>	M	BP		BP		
Demographic Questionnaire <sup>3</sup>	M, T	BP		BP		BP
Interviewer Impressions <sup>3</sup>	O	BP		BP		BP

Note.

<sup>1</sup> M = mailed questionnaire. T = telephone interview. CAPI = computer assisted personal interview. I = interviewer directed interview. O = coded observation.

<sup>2</sup> AP = adoptive parents, AF = adoptive family, AC = adopted child, BP = birth parents, BM = birth mother.

<sup>3</sup> Developed/modified for EGDS.

<sup>4</sup> BF PHC focuses on before and after conception of the child.

**Table 4**

Comparison Between Participants and Eligible Nonparticipants on Education, Income, and Age

Variable	Participants <i>M</i> ( <i>SD</i> )	Nonparticipants <i>M</i> ( <i>SD</i> )	<i>p</i>
BM education	4.87 (3.03)	4.64 (3.04)	0.29
BM income	1.23 (0.69)	1.17 (0.54)	0.32
BM age	23.84 (6.02)	24.58 (6.44)	0.08
BF education	5.09 (3.23)	5.47 (3.64)	0.32
BF income	1.29 (0.64)	1.19 (0.44)	0.24
BF age	25.61 (7.36)	27.30 (8.25)	0.01
AM education	9.18 (1.84)	8.67 (2.44)	0.001
AM age	36.98 (5.55)	37.54 (5.96)	0.15
AF education	8.86 (2.32)	8.56 (2.56)	0.09
AF age	37.82 (5.76)	38.34 (6.31)	0.20
AP income	5.01 (1.17)	4.86 (1.27)	0.09

*Note:* BM = birth mother. BF = birth father. AM = adoptive mother. AF = adoptive father. AP = adoptive parents. Education: 1 (< 8th grade), 2 (Completed 8th grade), 3 (Completed 12th grade), 4 (Some trade school), 5 (Completed trade school), 6 (Some junior college), 7 (Completed junior college), 8 (Some college), 9 (Completed college), 10 (Some professional/graduate school), 11 (Completed professional/graduate school). Income: 1 = \$20,000 or less; 3 = \$40,000-59,999; 5 = \$80,000-99,999.

**Table 5**

Self-Reported Level of Openness in the Adoption (Percentage of Participants)

<b>Level of openness</b>	<b>Birth mother</b>	<b>Adoptive mother</b>	<b>Adoptive father</b>
Very closed	0%	0%	0%
Closed	3%	6%	7%
Mediated	11%	18%	18%
Semi-open	16%	15%	14%
Open	34%	40%	40%
Quite open	19%	13%	13%
Very open	17%	8%	8%