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Older Siblings' Contributions to Young Child's Cognitive Skills

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Abstract

This work finds that older siblings as well as early parenting influence young children's cognitive skills directly or indirectly, for example, Mathematics, and English. Our findings challenge a pervasive view in the economical literatures that early parenting play a dominant role in explaining child development. In economics, early environmental conditions are important to demonstrate the evolution of adolescent and adult cognitive skills (Knudsen, Heckman, Cameron, and Shonkoff, 2006; Cunha and Heckman, 2007), and it establishes causal impacts of early parental inputs and other environmental factors on cognitive and non-cognitive skills (Heckman, Stixrud, and Urzua, 2006; Borghans, Duckworth, Heckman, and Weel, 2006; Cunha, Heckman, and Schennach, 2010). Early parenting as well as older siblings should explain a diverse array of academic and social outcomes, for example, Mathematics, English, marriage and pregnancy. In fact, older siblings' characteristics are as important, if not more important, than parenting for child development. Our analysis addresses the problems of measurement error, imperfect proxies, and reverse causality that plague conventional approach in psychology. We find that older brother contributes much more than older sister to child's mathematical achievement, while older sister contributes much more to child's english achievement. Our evidence is consistent with psychology literature, for example, Hetherington (1988), Jenkins (1992), Zukow-Goldring (1995), Marshall, Garcia-Coll, Marx, McCartney, Keffe, and Rub (1997), Maynard (2002), and Brody Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger (2003) for siblings' direct contributions to child development, Bronfenbrenner (1997), East (1998), Whiteman and Buchanan (2002), and Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger (2003) for siblings's indirect contributions, and Reiss, Neiderhiser, Hetherington, and Plomin (2000), Feinberg and Hetherington (2001), Kowal, Kramer, Krull, and Crick (2002) for parental differential treatment.

1 Introduction

Numerous economical literatures establish that early parenting from parents, grandparents and maternal grandparents contribute to children's cognitive skills and non-cognitive skills, for example, Mathematics, English. Less is well known in economics for the contribution of older siblings to children's cognitive skill, non-cognitive skill, and social behavior.

It is emerging in economics to demonstrate the importance of early environmental conditions on the evolution of adolescent and adult cognitive and non-cognitive skills (Knudsen, Heckman, Cameron, and Shonkoff, 2006; Cunha and Heckman, 2007). These skills determine educational attainment, crime, earnings, and participation in risky behaviors

(Heckman, Stixrud, and Urzua, 2006). It considers environmental influences on development over the entire life cycle of the child and into adulthood (Heckman, 2007). Cognitive and non-cognitive skills, including self-regulation, motivation, time preference, far-sightedness, adventurousness and the like, affect the evolution of health capital through choices made by parents and children. Aspects of personality and cognition determine health and healthy behaviors beyond their direct effect on education (Ryff and Singer, 2005; Heckman, Stixrud, and Urzua, 2006).

The economic literature on personality and preference formation establishes causal impacts of early parental inputs and other environmental factors on cognitive and non-cognitive skills (Heckman, Stixrud, and Urzua, 2006; Borghans, Duckworth, Heckman, and Weel, 2006; Cunha, Heckman, and Schennach, 2010). Early childhood interventions can affect personality traits and cognitive skill that promote health. A simple investment framework can analyze synergies in producing cognitive and non-cognitive skills (Heckman, Stixrud, and Urzua, 2006).

A growing psychology literature contributes sibling relationships for child and adolescent development. Interactions with older siblings promote young children's language and cognitive development, their understanding of other people's emotions and perspectives, and, conversely, their development of antisocial behavior (Hetherington, 1988; Jenkins, 1992; Zukow-Goldring, 1995; Marshall, Garcia-Coll, Marx, McCartney, Keffe, and Rub, 1997; Maynard, 2002; Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger, 2003). Parents with older child contribute to their rearing of younger child, which in turn contributes to the younger child development (Bronfenbrenner, 1997; East, 1998; Whiteman and Buchanan, 2002; Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger, 2003). Thus children may receive differential treatment from their parents (Reiss, Neiderhiser, Hetherington, and Plomin, 2000; Feinberg and Hetherington, 2001; Kowal, Kramer, Krull, and Crick, 2002). In psychology, younger siblings' outcomes are more accurate to predict if it is based on older siblings' characteristics plus parenting, rather than parenting alone.

This work presents an analysis of the influences of early parenting as well as old siblings on Mathematics, English, and cognitive skill. Our work concentrates, in economics, on younger siblings' outcomes considering older siblings' characteristics plus parenting. We find that both early parenting and older siblings influence child's cognitive skills directly or indirectly, for example, Mathematics, and English.

Our model differs from previous models (Heckman, Stixrud, and Urzua, 2006; Borghans, Duckworth, Heckman, and Weel, 2006; Cunha, Heckman, and Schennach, 2010) in including gender and kind garden, in particular, older siblings, in the model as explainable variables, except for early parenting from parents, grandparents and maternal grandparents. We allow those variables to influence Mathematics, English, and cognitive skills.

We find that early parenting as well as old siblings are important in explaining a variety of cognitive skills, for example, Mathematics, English. There are important gender differences in older siblings for child development, but old siblings play an important role for both men

and women child. In particular, we find that older brother contributes much more than older sister to young child's mathematical achievement, while older sister contributes much more to young child's english achievement.

For a variety of cognitive skills, a change in older siblings has an effect on skills comparable or greater than a corresponding change in early parenting. This evidence challenges a pervasive view in the economical literatures that early parenting play a important role in explaining child development (Carneiro and Heckman, 2003; Heckman and Masterov, 2004; Cunha, Heckman, Lochner, and Masterov, 2006; Heckman, Stixrud, and Urzua, 2006; Borghans, Duckworth, Heckman, and Weel, 2006; Cunha, Heckman, and Schennach, 2010).

Our approach recognizes that test scores measuring Mathematics, English and cognitive skill may be fallible. It also recognizes that a child's gender and kind garden, in particular, older siblings, at the time test are taken affect test scores. Observed parenting-ability and older-sibling-ability relationship may be the consequences of ability causing measured ability rather than the other way around. We correct measured test scores for these problems.

Our analysis supports that early environment affects the evolution of adolescent and adult cognitive and non-cognitive skills (Knudsen, Heckman, Cameron, and Shonkoff, 2006; Cunha and Heckman, 2007), we find that gender, early parenting, and kind garden determine the measures of cognitive skills that we study. We find that older siblings affects young siblings' cognitive skills through their direct effects as well as through their indirect effects via parents. Our evidence is consistent with psychology literature. For example, Hetherington (1988), Jenkins (1992), Zukow-Goldring (1995), Marshall, Garcia-Coll, Marx, McCartney, Keffe, and Rub (1997), Maynard (2002), and Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger (2003) find siblings' direct contributions to child development. Bronfenbrenner (1997), East (1998), Whiteman and Buchanan (2002), and Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger (2003) find siblings' indirect contributions. Reiss, Neiderhiser, Hetherington, and Plomin (2000), Feinberg and Hetherington (2001), Kowal, Kramer, Krull, and Crick (2002) find parental differential treatment with their children.

The remaining is organized as follows. Section 2 relates our analysis to previous work in the literature. Section 3 introduces the data used in our analysis and presents empirical results only considering the early parenting from parents, grandparents and maternal grandparents. We then discuss problems that plague this model. Section 4 presents our model including the contributions of gender and kind garden, in particular, older siblings, its implementation, and empirical evidence. Section 5 is for concluding remarks.

2 Related Literatures

Cognitive and non-cognitive skills can influence a variety of abilities, for example, schooling choice, wages, employment, occupation choice, and risky behaviors such as teenage pregnancy and marriage, smoking, marijuana use, and participation in illegal activities (Heckman, Stixrud, and Urzua, 2006). Early parental inputs and other environmental factors influence cognitive and non-cognitive skills. Knudsen, Heckman, Cameron, and Shonkoff (2006) finds that early environment influence the development of

cognitive and social skills. Cunha and Heckman (2007) and Cunha, Heckman, and Schennach (2010) apply nonlinear factor method to non-parametrically identify production function for children's cognitive and non-cognitive skills. Those economic literatures leave open older siblings's contribution to child's development. Our work find that early parenting as well as older siblings contribute to child's cognitive development. In the side of early parenting, our result is consistent with previous work. In our work, we need carefully consider measure error and reverse causality, since econometric model can not distinguish older siblings' direct contribution from indirect contribution, where reverse causality arises differently from the previous situations.

Psychology literature suggests that naturally occurring teaching and early-parenting experiences benefit cognitive and psychosocial development in both older and younger siblings. Jenkins (1992) compares the frequency of negative and positive sibling relationships in disharmonious and harmonious homes. Hetherington (1988), Zukow-Goldring (1995), Marshall, Garcia-Coll, Marx, McCartney, Keffe, and Rub (1997), and Maynard (2002) find that older siblings directly contribute to younger siblings' development. Parents' experiences with older children influence their expectations of subsequent children and the child-rearing strategies that parents consider effective (Whiteman and Buchanan, 2002). Bronfenbrenner (1997), East (1998), and Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger (2003) confirmed the operation of indirect effects on younger siblings' development. In addition, parental differential treatment contributes to child's development (Reiss, Neiderhiser, Hetherington, and Plomin, 2000; Feinberg and Hetherington, 2001; Kowal, Kramer, Krull, and Crick, 2002). Those literatures fall in the contribution of siblings to child development in psychology. We examine those results in economics. In economics, both small sample and reverse causality plague conventional approach which often applied in psychology. Therefore, on the siblings' contribution to child's development, our methodology is reasonable and much more approximate to real world.

It is instructive to compare our results on the influence of early parenting as well as older siblings on child's cognitive skills to the results from conventional approaches. The conventional approach suffers from several problems. First, Mathematics, English, cognitive scores are imperfect proxies of Mathematics, English, cognitive skills. We should consider measure error here. Second, since older siblings can influence younger siblings through their parents, there may exist reverse causality. Finally, small sample plagues psychometrics in child development. All these problems likely bias the estimates. Our work differs from the economical literatures till now in including older siblings' contribution, and from the present psychology literatures in treating with imperfect approximation, and reverse causality.

3 Some Evidence For Classical Model

This section presents a standard ordinary least squares analysis of the contributions of gender and early parenting from parents, grandparents and maternal grandparents on child's Mathematics, English and cognitive skill. We obtain the similar qualitative results to previous reports.

3.1 Data

Our data are from people in Wuhan, Hubei, P. R. China, which include students and neighbors from all around China. It contains cross-sectional data on gender, number of older siblings (female or male), length of education in kinder garden, early parenting from parents, grandparents and maternal grandparents, records of mathematics and English for a number of young persons, age 19 to 30 in 2012. This cohort has been followed ever since. Our data contains information on test scores for Mathematics and English.

Tests for Mathematics and English that we analyze are National Examination for University Entrance, test of Mathematics checks cognitive skills such as arithmetic reasoning and mathematical knowledge, while test of English check word knowledge, cloze, paragraph comprehension and English writing. We use the average of mathematical score and english score as a measure of cognitive skill.

3.2 Evidence from Classical Model

Table 1 and table 2 present the effects of early parenting, kinder garden, other than old siblings, on mathematical skill by gender. Table 3 and table 4 present the effects of early parenting, kinder garden, other than old siblings, on english skill by gender. Table 5 and table 6 present the effects of early parenting, kinder garden, other than old siblings, on cognitive skill by gender.

For women, Table 1.1–1.3 show the effects of the latent factors, other than older siblings, on mathematical skill. Early parentings from father and grandmother have positive effects, while others have negative effects. Father play a strongest positive role for female child's mathematical skill, but maternal grandfather play a strongest negative role. The significance levels are less than 0.91. While for men, Table 2.1–2.3 show the effects of the latent factors, other than older siblings, on mathematical skill. Early parentings from father, grandmother and maternal grandmother have positive effects, while others have negative effects. Grandmother play a strongest positive role for male child's mathematical skill, but maternal grandfather play a strongest negative role. The significance levels are less than 0.78.

For women, Table 3.1–3.3 show the effects of the latent factors, other than older siblings, on english skill. Early parentings from maternal grandmother have negative effects, while others have positive effects. Maternal grandfather play a strongest positive role for female child's english skill, but maternal grandmother play a strongest negative role. The significance levels are less than 0.86. While for men, Table 4.1–4.3 show the effects of the latent factors, other than older siblings, on English skill. Early parentings from mother and grandfather have negative effects, while others have positive effects. Maternal grandfather play a strongest positive role for male child's english skill, but grandfather play a strongest negative role. The significance levels are less than 0.98.

For women, Table 5.1–5.3 show the effects of the latent factors, other than older siblings, on cognitive skill. Early parentings from mother, grandfather, maternal grandmother and kinder garden have negative effects, while others have positive effects. Father play a strongest positive role for female child's cognitive skill, but maternal grandmother play a strongest negative role. The significance levels are less than 0.84. While for men, Table 6.1–6.3 show

the effects of the latent factors, other than older siblings, on cognitive skill. Early parentings from mother, grandfather and maternal grandfather have negative effects, while others have positive effects. Grandmother play a strongest positive role for male child's cognitive skill, but grandfather play a strongest negative role. The significance levels are less than 0.978.

Table 7.1–7.3 summarize the effects of the latent factors, including gender, other than older siblings, on cognitive skill. Early parentings from mother, grandfather, maternal grandfather, gender, and kinder garden have negative effects, while others have positive effects. Father play a strongest positive role for child's cognitive skill, but gender play a strongest negative role. The significance levels are less than 0.915.

For women, Table 8.1–8.3 show the effects of the latent factors, including English, other than older siblings, on mathematical skill. Early parentings from father, grandmother and English have positive effects, while others have negative effects. Father play a strongest positive role for female child's mathematical skill, but maternal grandfather play a strongest negative role. The significance levels are less than 0.963. While for men, Table 9.1–9.3 show the effects of the latent factors, including English, other than older siblings, on mathematical skill. Early parentings from mother, grandfather and maternal grandfather and kinder garden have negative effects, while others have positive effects. Grandmother play a strongest positive role for male child's mathematical skill, but maternal grandfather play a strongest negative role. The significance levels are less than 0.654.

For women, Table 10.1–10.3 show the effects of the latent factors, including Mathematics, other than older siblings, on english skill. Early parentings from maternal grandmother and kinder garden have negative effects, while others have positive effects. Maternal grandfather play a strongest positive role for female child's english skill, but kinder garden play a strongest negative role. The significance levels are less than 0.890. While for men, Table 11.1–11.3 show the effects of the latent factors, including Mathematics, other than older siblings, on english skill. Early parentings from grandmother and maternal grandmother have negative effects, while others have positive effects. Maternal grandfather play a strongest positive role for male child's english skill, but grandmother play a strongest negative role. The significance levels are less than 0.930.

Table 12.1–12.3 summarize the effects of the latent factors, including gender and English, other than older siblings, on mathematical skill. Early parentings from father, grandmother, maternal grandmother have positive effects, while others have negative effects. Ggender play a strongest positive role for child's mathematical skill, but maternal grandfather play a strongest negative role. The significance levels are less than 0.782.

Table 13.1–13.3 summarize the effects of the latent factors, including gender and Mathematics, other than older siblings, on english skill. Early parentings from maternal grandmother, and gender have negative effects, while others have positive effects. Maternal grandfather play a strongest positive role for child's english skill, but gender play a strongest negative role. The significance levels are less than 0.989.

3.3 Challenges of Classical Model

This evidence, as some evidence in economics, is ignorant of older siblings' contribution to young children's cognitive skills, since psychology literature found older siblings contribute to young children's cognitive skills as well as early parenting (see Hetherington, 1988; Jenkins, 1992; Zukow-Goldring, 1995; Marshall, Garcia-Coll, Marx, McCartney, Keffe, and Rub, 1997; Maynard, 2002; Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger, 2003; Bronfenbrenner, 1997; East, 1998; Whiteman and Buchanan, 2002; Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger, 2003). However, there are some problems. First, there is an important distinction between Mathematics, English and cognitive skill, although cognitive skill include Mathematics and English, but include much more. Second, there exists a reverse causality problem, since the least squares estimates cannot distinguish whether older siblings cause higher cognitive skills or whether older siblings cause both early parenting and higher measured cognitive skills. The latter is case that older siblings indirectly contribute to young child development. It may overstate the contribution of early parenting to young child's cognitive skills and understate the contribution of older siblings to young child's cognitive skills.

Measurement error and simultaneity in test scores require careful consideration of standard instrumental variable (IV) methods. First, the instruments selected for instrumental variables analysis are often controversial. Second, in a model with heterogeneous responses, it is out of understanding how instrumental variables can work out these problems (Heckman, Urzua, and Vytlačil, 2004; Heckman and Vytlačil, 2005). Unlike the IV strategy, we need empirical strategy (Heckman, Stixrud, and Urzua, 2006) to account for the problems of reverse causality and measurement error.

An alternative to IV is developed to postulate latent cognitive skills generating measured cognitive test scores, for example, Mathematics and English. Controlling for the latent cognitive skills solves the problems of endogeneity and measurement error. Extending Jöreskog and Goldberger (1975), Jöreskog (1977) and Heckman, Stixrud, and Urzua (2006), we account for the effects of choice variables (early parenting) and background variables on the measurements of cognitive skills where early parenting depends on the latent factors. Our model is a factor model with endogenous factor loadings. In a form of matching, the match variables that create the conditional independence are unobserved and their distributions are estimated non-parametrically (Carneiro, Hansen, and Heckman, 2003; Hansen, Heckman, and Mullen, 2004).

4 Incorporating Old Siblings into Classical Model

Much of the economic literature estimate the impact of gender, early parenting or kinder garden on child development, for example, Heckman, Stixrud, and Urzua (2006), Borghans, Duckworth, Heckman, and Weel (2006), Cunha, Heckman, and Schennach (2010). They all keep ignorant of older siblings' contribution.

We investigate the effects of gender, early parenting, and kinder garden, in particular, older siblings on individual' Mathematics, English, and cognitive skill, consistent with psychology literature (Hetherington, 1988; Jenkins, 1992; Zukow-Goldring, 1995; Marshall,

Garcia-Coll, Marx, McCartney, Keffe, and Rub, 1997; Maynard, 2002; Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger, 2003; Bronfenbrenner, 1997; East, 1998; Whiteman and Buchanan, 2002; Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger, 2003). Our model assumes that each skill is jointly determined by gender, early parenting, and kinder garden, in particular, older siblings.

4.1 A Model For Child's Mathematics, English And Cognitive Skill

Early parenting contributes much to child's development (Heckman, Stixrud, and Urzua, 2006; Borghans, Duckworth, Heckman, and Weel, 2006; Cunha, Heckman, and Schennach, 2010), thus it may affect child's Mathematics, English, and cognitive skill. Older siblings can also influence child development directly or indirectly (Hetherington, 1988; Jenkins, 1992; Zukow-Goldring, 1995; Marshall, Garcia-Coll, Marx, McCartney, Keffe, and Rub, 1997; Maynard, 2002; Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger, 2003; Bronfenbrenner, 1997; East, 1998; Whiteman and Buchanan, 2002; Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger, 2003).

Our empirical analysis suggests that early parenting as well as older siblings play multiple roles for child development. In our model, gender, number of older siblings (male or female), length of education in kinder garden, and early parenting from parents, grandparents and maternal grandparents all affect scores of Mathematics and English, therefore cognitive skill.

Here we postulate the existence of underlying factors representing latent Mathematics, English, and cognitive skill. The levels of an individual's latent factors may result from some combination of inherited ability, the quality of the environment provided by her parents, her early efforts and the effects of early interventions. The levels of latent factors are assumed known only by each individual, and are fixed by the time the individuals are measured. Let *Mat*, *Eng*, and *Cog* denote the levels of latent Mathematics, English, and cognitive skill respectively. It is traditional that one latent factor captures cognitive skill in the literature (Herrnstein and Murray, 1994; Heckman, 1995; Jensen, 1998), then it is similar for Mathematics and English, since cognitive skill include Mathematics and English.

We assume *Mat* and *Eng* mutually independent, and both determined by the individual's gender, number of older siblings, length of education in kinder garden, and early parenting. The assumption of independence between *Mat* and *Eng* is strong. The cross-correlations weaken further when conditioning on family background. We can account for the dependence across *Mat* and *Eng* test scores, even invoking independence between *Mat* and *Eng*. In particular, both factors affect early parenting.

The models are all in the form of linear-in-parameters index models. All distinctly subscripted, *e* variables (across each test skill) are mutually independent and independent of gender, early parenting, kinder garden, in particular, older siblings, and all controlled variables. This is a matching form where the match variables are independent. We now present our model for children's Mathematics.

4.1.1 The Model For Child's Mathematics—We consider child's mathematical skill determined by gender, number of older siblings (male or female), length of education in kinder garden, and early parenting from parents, grandparents and maternal grandparents. Let *Gen* denote the sex of child (1 for male, and 0 otherwise), *Bro* the number of older brothers of the child, *Sis* the number of older sisters of the child, *Kge* the number of years to stay in kinder garden, *Fat* if father involve the early parenting (1 for involvement, and 0 otherwise), *Mot* if mother involve the early parenting (1 for involvement, and 0 otherwise), *Gfat* if grandfather involve the early parenting (1 for involvement, and 0 otherwise), *Gmot* if grandmother involve the early parenting (1 for involvement, and 0 otherwise), *Mgfat* if maternal grandfather involve the early parenting (1 for involvement, and 0 otherwise), *Mgmot* if maternal grandmother involve the early parenting (1 for involvement, and 0 otherwise), and *Mat* the scores of his/her mathematics in National Examination. *Mat* are given by a linear equation of *Gen*, *Bro*, *Sis*, *Kge*, *Fat*, *Mot*, *Gfat*, *Gmot*, *Mgfat*, and *Mgmot*.

$$Mat = Const^M + \beta_0^M Gen + \beta_1^M Bro + \beta_2^M Sis + \beta_3^M Kge + \beta_4^M Fat + \beta_5^M Mot + \beta_6^M Gfat + \beta_8^M Gmot + \beta_9^M Mgfat + \beta_{10}^M Mgmot + e^M,$$

where e^M is an idiosyncratic error term such that $e^M \perp (Gen, Bro, Sis, Kge, Fat, Mot, Gfat, Gmot, Mgfat, Mgmot)$.

4.1.2 The Model For Child's English—Gender, number of older siblings, length of education in kinder garden, and early parenting from parents, grandparents and maternal grandparents determine child's english skill. Let *Eng* be the scores of his/her English in National Examination. *Eng* are given by a linear equation of *Gen*, *Bro*, *Sis*, *Kge*, *Fat*, *Mot*, *Gfat*, *Gmot*, *Mgfat*, and *Mgmot*.

$$Eng = Const^E + \beta_0^E Gen + \beta_1^E Bro + \beta_2^E Sis + \beta_3^E Kge + \beta_4^E Fat + \beta_5^E Mot + \beta_6^E Gfat + \beta_8^E Gmot + \beta_9^E Mgfat + \beta_{10}^E Mgmot + e^E,$$

where e^E is an idiosyncratic error term such that $e^E \perp (Gen, Bro, Sis, Kge, Fat, Mot, Gfat, Gmot, Mgfat, Mgmot)$.

4.1.3 The Model For Child's Cognitive Skill—Gender, number of older siblings, length of education in kinder garden, and early parenting from parents, grandparents and maternal grandparents determine child's cognitive skill. Let *Cog* be average score of his/her Mathematics and English in National Examination. *Cog* are given by a linear equation of *Gen*, *Bro*, *Sis*, *Kge*, *Fat*, *Mot*, *Gfat*, *Gmot*, *Mgfat*, and *Mgmot*.

$$Cog = Const^C + \beta_0^C Gen + \beta_1^C Bro + \beta_2^C Sis + \beta_3^C Kge + \beta_4^C Fat + \beta_5^C Mot + \beta_6^C Gfat + \beta_8^C Gmot + \beta_9^C Mgfat + \beta_{10}^C Mgmot + e^C,$$

where e^C is an idiosyncratic error term such that $e^C \perp (Gen, Bro, Sis, Kge, Fat, Mot, Gfat, Gmot, Mgfat, Mgmot)$.

4.2 Implementing the Model

Mathematics, English, and cognitive equations are estimated for individuals. Gender, older siblings, early parenting, and kinder garden are included in these equations. It assumes that, fixing these variables, all controlled variables do not affect Mathematics, English, and cognitive skill. Those test scores are from National Entrance Examinations in China.

Early parenting are from parents, grandparents and maternal grandparents to childhood, and Mathematics, English, and cognitive scores are from their National Entrance Examinations to University in China. Our mathematics, english, and cognitive scores depend on Mathematics, English, and cognitive skill, respectively. Each equation is estimated allowing the scores attained at the time of the test to affect means and factor loadings and includes controlled variables. Our cognitive measure is assumed average of the test scores of Mathematics and English, which is strong. These measures are chosen because of their availability in the National Entrance Examinations in China. Ideally, it would be better to use a wider array of psychological measurements for cognitive skill to include every cognitive components in economics.

For the reverse causality, it assumes the existence of two sets of measurements, with one set measuring Mathematics, and the other set measuring English. In this work, latent mathematical skill is only allowed to affect scores on Mathematics, latent english skill on English.

In general, we turn back Hansen, Heckman, and Mullen (2004) for the possibility of reverse causality among early parenting, old siblings, and test scores of Mathematics, English, and cognitive skill. In our work, the problem is unlikely to arise since we concentrate only on early parenting and older siblings' contribution in young childhood and test scores in National Examination in 18–19 years old.

Conditional on controlled variables, Mathematics, English, and cognitive skill all come through *Gen*, *Bro*, *Sis*, *Kge*, *Fat*, *Mot*, *Gfat*, *Gmot*, *Mgfat*, and *Mgmot*. If they were observed, we could match to control for this dependence, hence for the endogeneity in the model. We estimate the parameters of the model.

4.3 Evidence from the Model

The parameters of the model are estimated by ordinary least square method and presented in Tables 14–24. We find that both early parenting and older siblings contribute to child development. The first finding corroborates the analysis of Heckman, Stixrud, and Urzua (2006), Borghans, Duckworth, Heckman, and Weel (2006), and Cunha, Heckman, and Schennach (2010). The second analysis supports the psychology literature, for example, Hetherington (1988), Jenkins (1992), Zukow-Goldring (1995), Marshall, GarciaColl, Marx, McCartney, Keffe, and Rub (1997), Maynard (2002), Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger (2003), Bronfenbrenner (1997), East (1998), Whiteman and Buchanan (2002), Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger (2003).

We use data from people in Wuhan, Hubei, P. R. China, to corroborate the findings reported in this work. One potential advantage of these data is that they contain measurements from

university students, college students, and adult students. A disadvantage of these data is that they do not include sample from high school graduate without further study. In addition, small samples also challenge our results. Therefore the parameters are much less precisely estimated.

The model fits the data on Mathematics, English, and cognitive skills. Overall goodness of fit tests are passed for Mathematics, English, and cognitive skills. The loadings on gender, number of older siblings, length of education in kindergarten, and early parenting from parents, grandparents and maternal grandparents are statistically significant in most equations of the model. All variables are required to produce a model that passes goodness of fit tests.

Table 14.1–14.3 summarizes, for women, the effects of the latent factors including older brothers and sisters, on mathematical skill. Father, grandmother, kindergarten, older brothers and sisters have positive effects, while others have negative effects. Older brothers play strongest positive role for female child's mathematical skill, but maternal grandfather play a strongest negative role. The significance levels are less than 0.98. Table 15.1–15.3 summarizes, for men, the effects of the latent factors including older brothers and sisters, on mathematical skill. Father, grandmother, maternal grandmother and older brother have positive effects, while others have negative effects. Older brothers play strongest positive role for male child's mathematical skill, but maternal grandfather play a strongest negative role. The significance levels are less than 0.896.

Table 16.1–16.3 summarizes, for women, the effects of the latent factors including older brothers and sisters, on English skill. Maternal grandmother, kindergarten and older sister have negative effects, while others have positive effects. Maternal grandfather play a strongest positive role for female child's English skill, but older sisters play strongest negative role. The significance levels are less than 0.807. Table 17.1–17.3 summarizes, for men, the effects of the latent factors including older brothers and sisters, on English skill. Mother, grandfather, maternal grandmother and older sister have negative effects, while others have positive effects. Older brothers play strongest positive role for male child's English skill, but older sisters play strongest negative role. The significance levels are less than 0.962.

Table 18.1–18.3 displays, for women, the effects of the latent factors including older brothers and sisters, on cognitive skill. Mother, maternal grandmother, kindergarten and older sister have negative effects, while others have positive effects. Father play a strongest positive role for female child's cognitive skill, but mother play a strongest negative role. The significance levels are less than 0.99. Table 19.1–19.3 displays, for men, the effects of the latent factors including older brothers and sisters, on cognitive skill. Mother, grandfather, maternal grandfather and older sister have negative effects, while others have positive effects. Older brothers play strongest positive role for male child's cognitive skill, but grandfather play a strongest negative role. The significance levels are less than 0.884.

Table 20.1–20.3 summarize the effects of the latent factors, including gender and older brothers and sisters, on cognitive skill. Early parentings from older brother, father,

grandmother, maternal grandmother, and kinder garden have positive effects, while others have negative effects. Older brother play a strongest positive role for child's cognitive skill, but older sister play a strongest negative role. The significance levels are less than 0.998.

Table 21.1–21.3 summarize the effects of the latent factors, including gender and older brothers and sisters, on mathematical skill. Early parentings from older sister, mother, grandfather, maternal grandfather, and kinder garden have negative effects, while others have positive effects. Older brother play a strongest positive role for child's mathematical skill, but maternal grandfather play a strongest negative role. The significance levels are less than 0.986.

Table 22.1–22.3 summarize the effects of the latent factors, including gender and older brothers and sisters, on english skill. Early parentings from older sister and gender have negative effects, while others have positive effects. Maternal grandfather play a strongest positive role for child's english skill, but gender play a strongest negative role. The significance levels are less than 0.929.

Table 23.1–23.3 summarize the effects of the latent factors, including gender, older brothers and sisters and English, on mathematical skill. Early parentings from mother, grandfather, maternal grandfather, and Kinder garden have negative effects, while others have positive effects. Older brother play a strongest positive role for child's mathematical skill, but maternal grandfather play a strongest negative role. The significance levels are less than 0.953.

Table 24.1–24.3 summarize the effects of the latent factors, including gender, older brothers and sisters and Mathematics, on english skill. Early parentings from older sister and maternal grandmother, and gender have negative effects, while others have positive effects. Maternal grandfather play a strongest positive role for child's english skill, but gender play a strongest negative role. The significance levels are less than 0.979.

For both genders, older siblings, education in kinder garden, and early parenting explain a wide array of cognitive skills, for example, Mathematics, English. Old siblings play a major role in explaining these skills. See Table 14–24.

5 Conclusion

This paper establishes that older siblings as well as early parenting contribute to child development. Our findings challenge a pervasive view in the economics literatures that early parenting plays a dominant role in explaining child development. Although early parenting explain much more of the variance of cognitive skills, its effect on cognitive skills is similar to the effect of older siblings.

A model of older siblings as well as early parenting explains a diverse array of skills, for example, Mathematics, English. This work finds that both early parenting and older siblings influence child's cognitive skills directly or indirectly, for example, Mathematics, and English. In fact, older siblings's characteristics are as important, if not more important, than parenting for child development. In this paper, we find that older brother contributes much

more than older sister to child's mathematical achievement, while older sister contributes much more to child's english achievement.

Our evidence is consistent with economic literature for causal impacts of early parental inputs and other environmental factors on cognitive skills (Heckman, Stixrud, and Urzua, 2006; Cunha and Heckman, 2007; Cunha, Heckman, and Schennach, 2010). The economic literature establishes that early environmental conditions are important to demonstrate the evolution of adolescent and adult cognitive skills (Cunha and Heckman, 2007; Cunha, Heckman, and Schennach, 2010). Our evidence suggests that older siblings also plays a substantial role in influencing child development.

Our evidence is also consistent with psychology literature, for example, Jenkins (1992), Zukow-Goldring (1995), Marshall, Garcia-Coll, Marx, McCartney, Keffe, and Rub (1997), Hetherington (1988), and Maynard (2002) on older siblings' direct contributions to child development, Bronfenbrenner (1997), East (1998), Whiteman and Buchanan (2002), and Brody, Ge, Kim, Murry, Simons, Gibbons, Gerrard, and Conger (2003) on older siblings's indirect contributions. Our findings challenge a pervasive view in the economical literatures that parents play a dominant role in explaining child development. Our economic work treats with imperfect approximation, and reverse causality, which often plague conventional approach in psychology.

In dynamic influence of older siblings as well as early parenting on child development, imperfect approximation, reverse causality, and small sample may arise. Reverse causality may occur from several different resources, which makes estimation much more difficult. Small sample may bias estimation. This topic is left for future work.

Older siblings as well as early parenting should explain a diverse array of cognitive and social abilities, for example, Mathematics, English, maritage and pregnancy. Our evidence that older siblings are important in explaining achievements of Mathematics and English may help to explain the phenomena that children prefer to stay with older siblings. Our evidence of gender differentials in the effects of older siblings on certain behaviors may go part way in explaining the gender differentials found in the Perry Preschool program.

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Table 1.1

Model Summary in the Empirical Implementation of Mathematics for Female

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.269	.073	-.001	15.397

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden^b Gender = Female^c Dependent Variable: Mathematics

Table 1.2

ANOVA in the Empirical Implementation of Mathematics for Female

ANOVA ^{b,c}				
Model	Sum of Squares	df	Mean Square	F
Regression	1631.258	7	233.037	.983
Residual	20861.155	88	237.059	
Total	22492.413	95		

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Female

^c Dependent Variable: Mathematics

Table 1.3

Estimated Coefficients from Mathematics for Female

Variables	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		t
	B	Std. Error	Beta		
(Constant)	100.639	8.133			12.374
Father	7.315	4.847	.187		1.509
Mother	-12.850	8.906	-.187		-1.443
Grandfather	-6.316	5.129	-.183		-1.231
Grandmother	6.023	4.557	.188		1.322
Maternal Grandfather	-18.230	17.304	-.121		-1.054
Maternal Grandmother	-.873	7.407	-.014		-.118
Kinder Garden	-.238	1.380	-.018		-.173

^a Gender= Female

^b Dependent Variable: Mathematics

Table 2.1

Model Summary in the Empirical Implementation of Mathematics for Male

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.206	.043	-.035	21.107

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Male

^c Dependent Variable: Mathematics

Table 2.2

ANOVA in the Empirical Implementation of Mathematics for Male

ANOVA				
Model	Sum of Squares	df	Mean Square	F
Regression	1704.952	7	243.565	.547
Residual	38311.659	86	445.484	
Total	40016.611	93		

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Male

^c Dependent Variable: Mathematics

Table 2.3

Estimated Coefficients from Mathematics for Male

Variables	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		t
	B	Std. Error	Beta		
(Constant)	97.657	7.690			12.699
Father	4.069	5.796	.098		.702
Mother	-5.222	8.551	-.107		-.611
Grandfather	-11.424	7.670	-.213		-1.489
Grandmother	6.398	6.985	.137		.916
Maternal Grandfather	-15.818	16.884	-.111		-.937
Maternal Grandmother	3.712	9.309	.055		.399
Kinder Garden	-.552	1.910	-.031		-.289
					.773

^a Gender = Male

^b Dependent Variable: Mathematics

Table 3.1

Model Summary in the Empirical Implementation of English for Female

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.306	.094	.022	20.000

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Female

^c Dependent Variable: English

Table 3.2

ANOVA in the Empirical Implementation of English for Female

ANOVA					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	3643.925	7	520.561	1.301	.259
Residual	35200.033	88	400.000		
Total	38843.958	95			

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Female

^c Dependent Variable: English

Table 3.3

Estimated Coefficients from English for Female

Variables	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	75.447	10.565		7.141	.000
Father	8.143	6.296	.158	1.293	.199
Mother	5.356	11.568	.059	.463	.645
Grandfather	3.723	6.663	.082	.559	.578
Grandmother	6.481	5.920	.154	1.095	.277
Maternal Grandfather	24.696	22.478	.125	1.099	.275
Maternal Grandmother	-2.642	9.621	-.032	-.275	.784
Kinder Garden	-.322	1.792	-.019	-.180	.858

^a Gender = Female^b Dependent Variable: English

Table 4.1

Model Summary in the Empirical Implementation of English for Male

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.093	.009	-.072	19.084

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Male

^c Dependent Variable: English

Table 4.2

ANOVA in the Empirical Implementation of English for Male

ANOVA				
Model	Sum of Squares	df	Mean Square	F
Regression	272.803	7	38.972	.107
Residual	31321.026	86	364.198	
Total	31593.830	93		

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Male

^c Dependent Variable: English

Table 4.3

Estimated Coefficients from English for Male

Variables	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	76.842	6.953		11.051	.000
Father	2.457	5.240	.066	.469	.640
Mother	-.202	7.732	-.005	-.026	.979
Grandfather	-2.211	6.935	-.046	-.319	.751
Grandmother	.996	6.316	.024	.158	.875
Maternal Grandfather	4.485	15.266	.035	.294	.770
Maternal Grandmother	.379	8.417	.006	.045	.964
Kinder Garden	.795	1.727	.050	.460	.647

^a Gender = Male^b Dependent Variable: English

Table 5.1

Model Summary in the Empirical Implementation of Cognitive Skill for Female

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.291	.085	.012	14.178

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Female

^c Dependent Variable: Cognitive Skill

Table 5.2

ANOVA in the Empirical Implementation of Cognitive Skill for Female

ANOVA				
Model	Sum of Squares	df	Mean Square	F
Regression	1642.189	7	234.598	1.167
Residual	17689.770	88	201.020	
Total	19331.958	95		

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Female

^c Dependent Variable: Cognitive Skill

Table 5.3

Estimated Coefficients from Cognitive Skill for Female

Variables	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	88.061	7.489		11.758	.000
Father	7.747	4.463	.213	1.736	.086
Mother	-3.764	8.201	-.059	-.459	.647
Grandfather	-1.302	4.723	-.041	-.276	.783
Grandmother	6.236	4.197	.210	1.486	.141
Maternal Grandfather	3.219	15.935	.023	.202	.840
Maternal Grandmother	-1.763	6.821	-.030	-.259	.797
Kinder Garden	-.280	1.270	-.023	-.220	.826

^a Gender = Female^b Dependent Variable: Cognitive Skill

Table 6.1

Model Summary in the Empirical Implementation of Cognitive Skill for Male

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.140	.020	-.060	17.761

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden^b Gender = Male^c Dependent Variable: Cognitive Skill

Table 6.2

ANOVA in the Empirical Implementation of Cognitive Skill for Male

ANOVA				
Model	Sum of Squares	df	Mean Square	F Sig.
Regression	545.899	7	77.986	.247
Residual	27127.803	86	315.440	
Total	27673.702	93		

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Male

^c Dependent Variable: Cognitive Skill

Table 6.3

Estimated Coefficients from Cognitive Skill for Male

Variables	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	87.709	6.471		13.554	.000
Father	3.284	4.877	.095	.673	.503
Mother	-3.105	7.195	-.077	-.432	.667
Grandfather	-6.503	6.454	-.146	-1.008	.317
Grandmother	3.661	5.878	.094	.623	.535
Maternal Grandfather	-5.842	14.207	-.049	-.411	.682
Maternal Grandmother	1.839	7.834	.033	.235	.815
Kinder Garden	.044	1.608	.003	.027	.978

^a Gender = Male

^b Dependent Variable: Cognitive Skill

Table 7.1

Model Summary in the Empirical Implementation of Cognitive Skill Including Explainable Variable Gender

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.240	.057	.016	15.849

^a Predictors: (Constant), Gender, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Dependent Variable: Cognitive Skill

Table 7.2
ANOVA in the Empirical Implementation of Cognitive Skill Including Explainable Variable Gender

ANOVA				
Model	Sum of Squares	df	Mean Square	F
Regression	2769.428	8	346.179	1.378
Residual	45467.151	181	251.200	
Total	48236.579	189		

^a Predictors: (Constant), Gender, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Dependent Variable: Cognitive Skill

Table 7.3
Estimated Coefficients from Cognitive Skill Including Explainable Variable Gender

Coefficients						
Variable	Unstandardized Coefficients		Standardized Coefficients		t	Sig.
	B	Std. Error		Beta		
(Constant)	89.922	4.871			18.461	.000
Gender	-4.227	2.455		-.133	-1.721	.087
Father	5.589	3.235		.162	1.728	.086
Mother	-3.265	4.840		-.072	-.675	.501
Grandfather	-3.495	3.809		-.092	-.917	.360
Grandmother	5.338	3.418		.155	1.562	.120
Maternal Grandfather	-1.869	10.251		-.015	-.182	.856
Maternal Grandmother	1.062	4.968		.019	.214	.831
Kinder Garden	-.108	1.003		-.008	-.107	.915

^aDependent Variable: Cognitive Skill

Table 8.1

Model Summary in the Empirical Implementation of Mathematics Including Explainable Variable English for Female

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.372	.138	.059	14.928

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, English

^b Gender = Female

^c Dependent Variable: Mathematics

Table 8.2
Anova in the Empirical Implementation of Mathematics Including Explainable Variable English for Female

Anova				
Model	Sum of Squares	df	Mean Square	F
Regression	3105.628	8	388.203	1.742
Residual	19386.786	87	222.837	
Total	22492.413	95		

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, English

^b Gender = Female

^c Dependent Variable: Mathematics

Table 8.3
Estimated Coefficients from Mathematics Including Explainable Variable English for Female

Variables	Coefficients					Sig.
	Unstandardized Coefficients		Standardized Coefficients		t.	
	B	Std. Error	Beta			
(Constant)	85.198	9.910			8.597	.000
Father	5.648	4.744	.144		1.191	.237
Mother	-13.946	8.645	-.202		-1.613	.110
Grandfather	-7.077	4.982	-.205		-1.421	.159
Grandmother	4.697	4.449	.147		1.056	.294
Maternal Grandfather	-23.285	16.892	-.154		-1.378	.172
Maternal Grandmother	-.333	7.184	-.005		-.046	.963
Kinder Garden	-.172	1.338	-.013		-.129	.898
English	.205	.080	.269		2.572	.012

^a Gender = Female

^b Dependent Variable: Mathematics

Table 9.1

Model Summary in the Empirical Implementation of Mathematics Including Explainable Variable English for Male

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.588	.346	.285	17.544

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, English

^b Gender = Male

^c Dependent Variable: Mathematics

Table 9.2
Anova in the Empirical Implementation of Mathematics Including Explainable Variable English for Male

Anova				
Model	Sum of Squares	df	Mean Square	F
Regression	13854.684	8	1731.836	5.627
Residual	26161.927	85	307.787	
Total	40016.611	93		

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, English

^b Gender = Male

^c Dependent Variable: Mathematics

Table 9.3
Estimated Coefficients from Mathematics Including Explainable Variable English for Male

Variables	Coefficients				Sig.	
	Unstandardized Coefficients		Standardized Coefficients			t.
	B	Std. Error	Beta			
(Constant)	49.799	9.944			5.008	.000
Father	2.539	4.824	.061		.526	.600
Mother	-5.096	7.108	-.105		-.717	.475
Grandfather	-10.047	6.379	-.187		-1.575	.119
Grandmother	5.778	5.807	.124		.995	.323
Maternal Grandfather	-18.611	14.041	-.130		-1.325	.189
Maternal Grandmother	3.476	7.738	.052		.449	.654
Kinder Garden	-1.047	1.590	-.058		-.659	.512
English	.623	.099	.553		6.283	.000

^a Gender = Male

^b Dependent Variable: Mathematics

Table 10.1

Model Summary in the Empirical Implementation of English Including Explainable Variable Mathematics for Female

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.397	.158	.080	19.391

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, Mathematics

^b Gender = Female

^c Dependent Variable: English

Table 10.2
Anova in the Empirical Implementation of English Including Explainable Variable Mathematics for Female

Anova				
Model	Sum of Squares	df	Mean Square	F
Regression	6131.699	8	766.462	2.038
Residual	32712.259	87	376.003	
Total	38843.958	95		

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, Mathematics

^b Gender = Female

^c Dependent Variable: English

Table 10.3
Estimated Coefficients from English Including Explainable Variable Mathematics for Female

Variables	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t.	
(Constant)	40.693	16.955		2.400	.019
Father	5.617	6.183	.109	.908	.366
Mother	9.793	11.348	.108	.863	.390
Grandfather	5.904	6.515	.130	.906	.367
Grandmother	4.401	5.796	.105	.759	.450
Maternal Grandfather	30.992	21.930	.156	1.413	.161
Maternal Grandmother	-2.340	9.329	-.028	-.251	.803
Kinder Garden	-.240	1.738	-.014	-.138	.890
Mathematics	.345	.134	.263	2.572	.012

^a Gender = Female

^b Dependent Variable: English

Table 11.1

Model Summary in the Empirical Implementation of English Including Explainable Variable Mathematics for Male

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.568	.323	.259	15.863

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, Mathematics

^b Gender = Male

^c Dependent Variable: English

Table 11.2
Anova in the Empirical Implementation of English Including Explainable Variable Mathematics for Male

Anova				
Model	Sum of Squares	df	Mean Square	F
Regression	10205.604	8	1275.701	5.070
Residual	21388.226	85	251.626	
Total	31593.830	93		

^a Predictors: (Constant), Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, Mathematics

^b Gender = Male

^c Dependent Variable: English

Table 11.3
Estimated Coefficients from English Including Explainable Variable Mathematics for Male

Variables	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t.	
(Constant)	27.116	9.800		2.767	.007
Father	.385	4.368	.010	.088	.930
Mother	2.457	6.440	.057	.382	.704
Grandfather	3.606	5.838	.076	.618	.538
Grandmother	-2.262	5.275	-.055	-.429	.669
Maternal Grandfather	12.539	12.754	.099	.983	.328
Maternal Grandmother	-1.511	7.003	-.025	-.216	.830
Kinder Garden	1.076	1.436	.068	.749	.456
Mathematics	.509	.081	.573	6.283	.000

^a Gender = Male

^b Dependent Variable: English

Table 12.1

Model Summary in the Empirical Implementation of Mathematics Including Explainable Variables Gender and English

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.467	.218	.179	16.483

^aPredictors: (Constant), Gender, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, English

^bDependent Variable: Mathematics

Table 12.2
Anova in the Empirical Implementation of Mathematics Including Explainable Variables Gender and English

Anova				
Model	Sum of Squares	df	Mean Square	F
Regression	13629.941	9	1514.438	5.574
Residual	48905.259	180	271.696	
Total	62535.200	189		

^a Predictors: (Constant), Gender, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, English

^b Dependent Variable: Mathematics

Table 12.3
Estimated Coefficients from Mathematics Including Explainable Variables Gender and English

Coefficients						
Variables	Unstandardized Coefficients		standardized Coefficients		t.	Sig.
	B	Std. Error		Beta		
(Constant)	65.075	7.231			8.999	.000
Gender	4.238	2.618		.117	1.618	.107
Father	3.462	3.382		.088	1.024	.307
Mother	-8.355	5.034		-.161	-1.660	.099
Grandfather	-8.442	3.962		-.195	-2.131	.034
Grandmother	4.049	3.567		.103	1.135	.258
Maternal Grandfather	-22.042	10.693		-.151	-2.061	.041
Maternal Grandmother	1.431	5.167		.022	.277	.782
Kinder Garden	-.528	1.044		-.034	-.506	.613
English	.399	.063		.441	6.308	.000

^aDependent Variable: Mathematics

Table 13.1

Model Summary in the Empirical Implementation of English Including Explainable Variables Gender and Mathematics

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.520	.270	.234	17.585

^aPredictors: (Constant), Gender, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, Mathematics

^bDependent Variable: English

Table 13.2

Anova in the Empirical Implementation of English Including Explainable Variables Gender and Mathematics

Anova				
Model	Sum of Squares	df	Mean Square	F
Regression	20633.348	9	2292.594	7.414
Residual	55659.726	180	309.221	
Total	76293.074	189		

^a Predictors: (Constant), Gender, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, Mathematics

^b Dependent Variable: English

Table 13.3
Estimated Coefficients from English Including Explainable Variables Gender and Mathematics

Coefficients						
Variables	Unstandardized Coefficients		Standardized Coefficients		t.	Sig.
	B	Std. Error	Beta			
(Constant)	37.296	8.863			4.208	.000
Gender	−9.417	2.725		−.235	−3.456	.001
Father	2.927	3.612		.067	.810	.419
Mother	5.210	5.398		.091	.965	.336
Grandfather	4.572	4.266		.095	1.072	.285
Grandmother	2.039	3.816		.047	.534	.594
Maternal Grandfather	20.817	11.437		.130	1.820	.070
Maternal Grandmother	−.078	5.513		−.001	−.014	.989
Kinder Garden	.463	1.114		.027	.416	.678
Mathematics	.454	.072		.411	6.308	.000

^aDependent Variable: English

Table 14.1

Model Summary in the Empirical Implementation of Mathematics Including Explainable Variables Older Brother and Sister for Female

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.381	.145	.056	14.950

^aPredictors: (Constant), Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^bGender = Female

^cDependent Variable: Mathematics

Table 14.2
Anova in the Empirical Implementation of Mathematics Including Explainable Variables Older Brother and Sister for Female

Anova				
Model	Sum of Squares	df	Mean Square	F
Regression	3269.959	9	363.329	1.626
Residual	19222.454	86	223.517	
Total	22492.413	95		

^a Predictors: (Constant), Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Female

^c Dependent Variable: Mathematics

Table 14.3
Estimated Coefficients from Mathematics Including Explainable Variables Older Brother and Sister for Female

Variables	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	95.367	8.257		11.550	.000
Older Brother	7.805	2.886	.284	2.704	.008
Older Sister	1.209	3.842	.033	.315	.754
Father	6.296	4.756	.161	1.324	.189
Mother	-10.849	8.683	-.157	-1.249	.215
Grandfather	-3.542	5.090	-.103	-.696	.488
Grandmother	6.149	4.441	.192	1.385	.170
Maternal Grandfather	-14.636	16.878	-.097	-.867	.388
Maternal Grandmother	-.178	7.200	-.003	-.025	.980
Kinder Garden	.412	1.371	.031	.300	.765

^a Gender = Female

^b Dependent Variable: Mathematics

Table 15.1

Model Summary in the Empirical Implementation of Mathematics Including Explainable Variables Older Brother and Sister for Male

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.305	.093	-.004	20.783

^aPredictors: (Constant), Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^bGender = Male

^cDependent Variable: Mathematics

Table 15.2
Anova in the Empirical Implementation of Mathematics Including Explainable Variables Older Brother and Sister for Male

ANOVA ^{b,c}				
Model	Sum of Squares	df	Mean Square	F
Regression	3733.785	9	414.865	.960
Residual	36282.826	84	431.938	
Total	40016.611	93		

^a Predictors: (Constant), Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Male

^c Dependent Variable: Mathematics

Table 15.3
Estimated Coefficients from Mathematics Including Explainable Variables Older Brother and Sister for Male

Coefficients						
Variables	Unstandardized Coefficients		Standardized Coefficients		t	Sig.
	B	Std. Error		Beta		
(Constant)	95.615	8.219			11.634	.000
Older Brother	10.594	5.711		.202	1.855	.067
Older Sister	-1.916	2.498		-.084	-.767	.445
Father	5.724	5.782		.137	.990	.325
Mother	-5.902	8.467		-.121	-.697	.488
Grandfather	-11.735	7.604		-.219	-1.543	.127
Grandmother	7.595	6.903		.163	1.100	.274
Maternal Grandfather	-13.531	16.827		-.095	-.804	.424
Maternal Grandmother	3.174	9.171		.047	.346	.730
Kinder Garden	-.257	1.959		-.014	-.131	.896

^a Gender = Male

^b Dependent Variable: Mathematics

Table 16.1

Model Summary in the Empirical Implementation of English Including Explainable Variables Older Brother and Sister for Female

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.325	.106	.012	20.097

^aPredictors: (Constant), Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^bGender = Female

^cDependent Variable: English

Table 16.2
Anova in the Empirical Implementation of English Including Explainable Variables Older Brother and Sister for Female

ANOVA				
Model	Sum of Squares	df	Mean Square	Sig.
Regression	4110.166	9	456.685	1.131
Residual	34733.793	86	403.881	
Total	38843.958	95		

^a Predictors: (Constant), Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Female

^c Dependent Variable: English

Table 16.3
Estimated Coefficients from English Including Explainable Variables Older Brother and Sister for Female

Coefficients						
Variable	Unstandardized Coefficients		Standardized Coefficients		t	Sig.
	B	Std. Error		Beta		
(Constant)	76.966	11.100			6.934	.000
Older Brother	.953	3.880		.026	.246	.807
Older Sister	-5.308	5.165		-.109	-1.028	.307
Father	7.233	6.393		.140	1.131	.261
Mother	5.923	11.672		.065	.507	.613
Grandfather	3.655	6.843		.081	.534	.595
Grandmother	5.972	5.969		.142	1.000	.320
Maternal Grandfather	23.781	22.688		.120	1.048	.297
Maternal Grandmother	-2.902	9.679		-.035	-.300	.765
Kinder Garden	-.495	1.843		-.029	-.269	.789

^a Gender = Female

^b Dependent Variable: English

Table 17.1

Model Summary in the Empirical Implementation of English Including Explainable Variables Older Brother and Sister for Male

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.343	.117	.023	18.220

^a Predictors: (Constant), Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Male

^c Dependent Variable: English

Table 17.2
Anova in the Empirical Implementation of English Including Explainable Variables Older Brother and Sister for Male

ANOVA ^{a,c}				
Model	Sum of Squares	df	Mean Square	F
Regression	3709.721	9	412.191	1.242
Residual	27884.109	84	331.954	
Total	31593.830	93		

^a Predictors: (Constant), Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden
^b Gender = Male
^c Dependent Variable: English

Table 17.3
Estimated Coefficients from English Including Explainable Variables Older Brother and Sister for Male

Variable	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	75.617	7.205		10.495	.000
Older Brother	12.251	5.007	.263	2.447	.016
Older Sister	-3.531	2.190	-.175	-1.612	.111
Father	4.824	5.069	.130	.952	.344
Mother	-1.460	7.423	-.034	-.197	.845
Grandfather	-3.010	6.666	-.063	-.452	.653
Grandmother	2.442	6.051	.059	.404	.688
Maternal Grandfather	6.334	14.751	.050	.429	.669
Maternal Grandmother	-.382	8.040	-.006	-.047	.962
Kinder Garden	.931	1.717	.058	.542	.589

^a Gender = Male
^b Dependent Variable: English

Table 18.1

Model Summary in the Empirical Implementation of Cognitive Skill Including Explainable Variables Older Brother and Sister for Female

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.341	.117	.024	14.092

^aPredictors: (Constant), Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^bGender = Female

^cDependent Variable: Cognitive Skill

Table 18.2
ANOVA in the Empirical Implementation of Cognitive Skill Including Explainable Variables Older Brother and Sister for Female

ANOVA					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	2252.614	9	250.290	1.260	.270
Residual	17079.345	86	198.597		
Total	19331.958	95			

^aPredictors: (Constant), Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^bGender = Female

Table 18.3
Estimated Coefficients from Cognitive Skill Including Explainable Variables Older Brother and Sister for Female

Variable	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	86.178	7.783		11.072	.000
Older Brother	4.400	2.721	.173	1.617	.109
Older Sister	-2.064	3.622	-.060	-.570	.570
Father	6.777	4.483	.186	1.512	.134
Mother	-2.473	8.185	-.039	-.302	.763
Grandfather	.058	4.798	.002	.012	.990
Grandmother	6.043	4.186	.204	1.444	.152
Maternal Grandfather	4.564	15.910	.033	.287	.775
Maternal Grandmother	-1.545	6.787	-.026	-.228	.820
Kinder Garden	-.041	1.292	-.003	-.031	.975

^a Gender = Female
^b Dependent Variable: Cognitive Skill

Table 19.1

Model Summary in the Empirical Implementation of Cognitive Skill Including Explainable Variables Older Brother and Sister for Male

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.340	.116	.021	17.069

^aPredictors: (Constant), Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^bGender= Male

^cDependent Variable: Cognitive Skill

Table 19.2

ANOVA in the Empirical Implementation of Cognitive Skill Including Explainable Variables Older Brother and Sister for Male

ANOVA					
Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	3201.299	9	355.700	1.221	.293
Residual	24472.403	84	291.338		
Total	27673.702	93			

^a Predictors: (Constant), Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^b Gender = Male

^c Dependent Variable: Cognitive Skill

Table 19.3
Estimated Coefficients from Cognitive Skill Including Explainable Variables Older Brother and Sister for Male

Variable	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	86.216	6.750		12.773	.000
Older Brother	11.244	4.690	.258	2.397	.019
Older Sister	-2.814	2.052	-.149	-1.371	.174
Father	5.309	4.749	.153	1.118	.267
Mother	-4.107	6.954	-.101	-.591	.556
Grandfather	-7.093	6.245	-.159	-1.136	.259
Grandmother	4.968	5.669	.128	.876	.383
Maternal Grandfather	-3.887	13.819	-.033	-.281	.779
Maternal Grandmother	1.186	7.532	.021	.157	.875
Kinder Garden	.236	1.609	.016	.146	.884

^a Gender = Male
^b Dependent Variable: Cognitive Skill

Table 20.1

Model Summary in the Empirical Implementation of Cognitive Skill Including Explainable Variables Gender, Older Brother and Sister

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.340	.115	.066	15.439

^aPredictors: (Constant), Gender, Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^bDependent Variable: Cognitive Skill

Table 20.2
ANOVA in the Empirical Implementation of Cognitive Skill Including Explainable Variables Gender, Older Brother and Sister

ANOVA				
Model	Sum of Squares	df	Mean Square	F
Regression	5567.394	10	556.739	2.336
Residual	42669.184	179	238.375	
Total	48236.579	189		

^aPredictors: (Constant), Gender, Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^bDependent Variable: Cognitive Skill

Table 20.3
Estimated Coefficients from Cognitive Skill Including Explainable Variables Gender, Older Brother and Sister

Variable	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	87.670	5.022		17.457	.000
Gender	−2.453	2.456	−.077	−.999	.319
Older Brother	6.434	2.420	.196	2.659	.009
Older Sister	−2.948	1.650	−.133	−1.786	.076
Father	5.820	3.159	.168	1.842	.067
Mother	−2.860	4.735	−.063	−.604	.547
Grandfather	−2.640	3.764	−.069	−.701	.484
Grandmother	5.514	3.332	.160	1.655	.100
Maternal Grandfather	−1.352	10.067	−.011	−.134	.893
Maternal Grandmother	1.329	4.842	.023	.274	.784
Kinder Garden	.002	1.008	.000	.002	.998

^aDependent Variable: Cognitive Skill

Table 21.1

Model Summary in the Empirical Implementation of Mathematics Including Explainable Variables Gender, Older Brother and Sister

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.313	.098	.048	17.749

^aPredictors: (Constant), Gender, Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^bDependent Variable: Mathematics

Table 21.2
ANOVA in the Empirical Implementation of Mathematics Including Explainable Variables Gender, Older Brother and Sister

ANOVA				
Model	Sum of Squares	df	Mean Square	Sig.
Regression	6144.919	10	614.492	.041
Residual	56390.281	179	315.030	
Total	62535.200	189		

^aPredictors: (Constant), Gender, Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^bDependent Variable: Mathematics

Table 21.3
Estimated Coefficients from Mathematics Including Explainable Variables Gender, Older Brother and Sister

Variable	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		Sig.
	B	Std. Error	Beta	t	
(Constant)	93.527	5.773		16.200	.000
Gender	2.178	2.824	.060	.771	.442
Older Brother	8.449	2.782	.226	3.037	.003
Older Sister	-1.404	1.897	-.056	-.740	.460
Father	5.647	3.631	.143	1.555	.122
Mother	-6.746	5.444	-.130	-1.239	.217
Grandfather	-6.517	4.327	-.150	-1.506	.134
Grandmother	6.276	3.831	.160	1.638	.103
Maternal Grandfather	-14.753	11.573	-.101	-1.275	.204
Maternal Grandmother	2.154	5.567	.033	.387	.699
Kinder Garden	-.020	1.159	-.001	-.018	.986

^aDependent Variable: Mathematics

Table 22.1

Model Summary in the Empirical Implementation of English Including Explainable Variables Gender, Older Brother and Sister

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.383	.147	.099	19.072

^aPredictors: (Constant), Gender, Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^bDependent Variable: English

Table 22.2
ANOVA in the Empirical Implementation of English Including Explainable Variables Gender, Older Brother and Sister

ANOVA				
Model	Sum of Squares	df	Mean Square	Sig.
Regression	11180.147	10	1118.015	.001
Residual	65112.927	179	363.759	
Total	76293.074	189		

^aPredictors: (Constant), Gender, Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden

^bDependent Variable: English

Table 22.3

Estimated Coefficients from English Including Explainable Variables Gender, Older Brother and Sister

Variable	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		t
	B	Std. Error	Beta		
(Constant)	81.106	6.204			13.074
Gender	−7.220	3.034	−.180		−2.379
Older Brother	4.489	2.990	.109		1.502
Older Sister	−4.365	2.039	−.157		−2.141
Father	5.943	3.902	.137		1.523
Mother	1.651	5.849	.029		.282
Grandfather	1.087	4.649	.023		.234
Grandmother	4.757	4.116	.110		1.156
Maternal Grandfather	12.304	12.436	.077		.989
Maternal Grandmother	.798	5.982	.011		.133
Kinder Garden	.111	1.245	.006		.089

^aDependent Variable: English

Table 23.1

Model Summary in the Empirical Implementation of Mathematics Including Explainable Variables Gender, Older Brother and Sister, and English

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.497	.247	.201	16.261

^aPredictors: (Constant), Gender, Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, English

^bDependent Variable: Mathematics

Table 23.2
ANOVA in the Empirical Implementation of Mathematics Including Explainable Variables Gender, Older Brother and Sister, and English

ANOVA				
Model	Sum of Squares	df	Mean Square	Sig.
Regression	15468.079	11	1406.189	.000
Residual	47067.120	178	264.422	
Total	62535.200	189		

^aPredictors: (Constant), Gender, Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, English

^bDependent Variable: Mathematics

Table 23.3
Estimated Coefficients from Mathematics Including Explainable Variables Gender, Older Brother and Sister, and English

Variable	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		t
	B	Std. Error	Beta	Sig.	
(Constant)	62.837	7.395		.000	8.497
Gender	4.910	2.628	.135	.063	1.868
Older Brother	6.751	2.565	.181	.009	2.632
Older Sister	.248	1.760	.010	.888	.141
Father	3.398	3.348	.086	.311	1.015
Mother	-7.371	4.988	-.142	.141	-1.478
Grandfather	-6.929	3.965	-.160	.082	-1.748
Grandmother	4.476	3.523	.114	.206	1.271
Maternal Grandfather	-19.409	10.632	-.133	.070	-1.826
Maternal Grandmother	1.853	5.100	.028	.717	.363
Kinder Garden	-.063	1.061	-.004	.953	-.059
English	.378	.064	.418	.000	5.938

^aDependent Variable: Mathematics

Table 24.1

Model Summary in the Empirical Implementation of English Including Explainable Variables Gender, Older Brother and Sister, and Mathematics

Model Summary			
R	R Square	Adjusted R Square	Std. Error of the Estimate
.536	.288	.244	17.474

^aPredictors: (Constant), Gender, Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, Mathematics

^bDependent Variable: English

Table 24.2
ANOVA in the Empirical Implementation of English Including Explainable Variables Gender, Older Brother and Sister, and Mathematics

ANOVA				
Model	Sum of Squares	df	Mean Square	F
Regression	21945.446	11	1995.041	6.534
Residual	54347.628	178	305.324	
Total	76293.074	189		

^aPredictors: (Constant), Gender, Older Brother, Older Sister, Father, Mother, Grandfather, Grandmother, Maternal Grandfather, Maternal Grandmother, Kinder Garden, Mathematics

^bDependent Variable: English

Table 24.3
Estimated Coefficients from English Including Explainable Variables Gender, Older Brother and Sister, and Mathematics

Variable	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	
(Constant)	40.241	8.926		4.509	.000
Gender	−8.172	2.785	−.204	−2.935	.004
Older Brother	.798	2.809	.019	.284	.777
Older Sister	−3.752	1.871	−.135	−2.006	.046
Father	3.475	3.599	.080	.966	.336
Mother	4.599	5.382	.080	.854	.394
Grandfather	3.935	4.287	.082	.918	.360
Grandmother	2.015	3.799	.047	.530	.596
Maternal Grandfather	18.750	11.445	.117	1.638	.103
Maternal Grandmother	−.144	5.483	−.002	−.026	.979
Kinder Garden	.120	1.141	.007	.105	.916
Mathematics	.437	.074	.396	5.938	.000

^aDependent Variable: English