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4 Why Siblings Are Like Darwin's Finches: Birth Order, Sibling Competition, and Adaptive Divergence within the Family

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Parents often express surprise at the range of differences in their children's personalities. For example, one child may be unusually fun-loving and sociable, whereas another child may be shy and introverted. Or one child might be a highly organized neat-freak, but another may revel in clutter. A Darwinian perspective on family dynamics sheds considerable light on these kinds of sibling differences, which are driven by principles that are well known to evolutionary biologists.

Given their impressive disparities, human siblings are a lot like Darwin's finches, that famous group of birds from the Galápagos Islands that has played such an important role in evolutionary theory. The 14 species of Darwin's finches are all derived from a single ancestor that colonized these volcanic islands more than two million years ago (Grant & Grant, 2008). From an ancestral species that is thought to have resembled the present-day warbler finch, the original colonists have evolved into 7 species of insectivorous tree finches, 2 species that consume the flowers and fruits of cactus, 1 species that eats fruits and leaves, and 4 species of ground finches that have their beaks graduated according to the size of the seeds they consume (Figure 4.1). So extensive is the diversity among the 14 species in this remarkable avian subfamily that Charles Darwin, during his five-week visit to the Galápagos Islands in 1835, mistook some of these finch species for members of distinctly different bird families. Only after returning to England

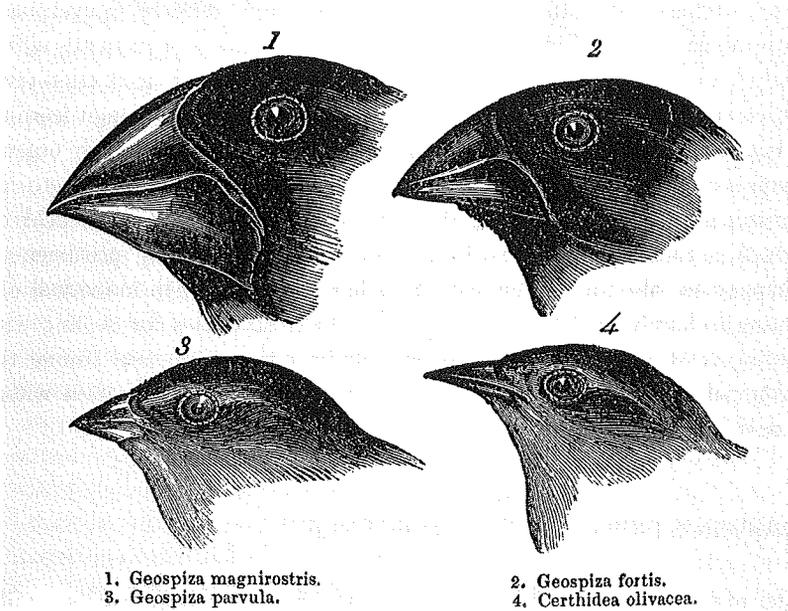


Figure 4.1. Four of the 14 species of Darwin's Galápagos finches (*Geospizinae*), illustrated in the second edition of Darwin's *Journal of Researches* (1845:379). *Top left*, the large ground finch; *top right*, the medium ground finch; *bottom left*, the small tree finch; *bottom right*, the warbler finch, which is closest to the ancestral form of this avian group.

was Darwin convinced by John Gould (1837), a distinguished British ornithologist, that these species were all closely related, prompting Darwin to surmise their evolutionary origins (Sulloway, 1982). Commenting in the second edition of his *Journal of Researches* about the extraordinary range of morphology found within this closely related avian group, Darwin hinted at the evolutionary explanation he revealed to the world fourteen years later in the *Origin of Species* (1859): "Seeing this gradation and diversity of structure in one small, intimately related group of birds, one might really fancy that from an original paucity of birds in this archipelago, one species had been taken and modified for different ends" (1845:380).

Like Darwin's Galápagos finches, human siblings tend to diversify in adaptive ways. Whereas Darwin's finches have diverged phylogenetically, through the gradual evolution of genetic differences, human siblings become increasingly dissimilar during ontogeny, through learned differences in family

roles, strategies, and other behaviors. Such behavioral differences eventually become encapsulated in personality as well as in familial sentiments, which include attitudes toward parental authority and feelings of closeness toward other family members. The fact that humans accomplish through learning what Darwin's finches and other species have achieved through organic evolution does not mean that sibling behavior is no longer subject to the pressures of evolution by natural selection. Rather, the playing field on which natural selection expresses itself includes not only phylogenetic changes but also various ontogenetic adaptations that help individual offspring to survive childhood and to reproduce. Strategies for dealing with sibling competition, and for evoking sibling cooperation, are among the principal functional mechanisms that govern successful adaptation within family life.

DARWIN'S PRINCIPLE OF DIVERGENCE

The main reason why Darwin's finches and human siblings have so much in common goes back to what Darwin (1859) termed his "principle of divergence." To use one of Darwin's own examples from the *Origin*, if a plot of ground is sown with several different species of grasses, rather than with a single species, a larger number of plants and a greater weight of dry herbage can be reaped from this plot because the different species do not compete for the same limited resources. Natural selection, Darwin argued, tends to favor species that face the least competition from other organisms. Darwin's principle of divergence explains why species become increasingly disparate over time. Along with the theory of natural selection, Darwin considered his principle of divergence to be the "keystone" of his revolutionary arguments about the evolutionary process (Darwin, 1991; 8 June 1858 letter to Joseph Hooker).

One of the most compelling demonstrations of Darwin's principle of divergence is a phenomenon known as character displacement, or the process by which morphological differences arise in two or more closely related species when they overlap geographically. Darwin's finches provided one of the earliest documented examples of this evolutionary process (Brown & Wilson, 1956; Lack, 1947). Upwards of 10 different species of Darwin's finches coexist on the largest islands within the Galápagos group. Nevertheless, some islands have a much smaller number of species. On islands where only one or two species of ground finches are resident, the birds have developed a generalist beak size to take advantage of a wider range of available resources, thus venturing into niches normally occupied by other closely related species (Figure 4.2). Over millions of years, the cumulative outcome of repeated

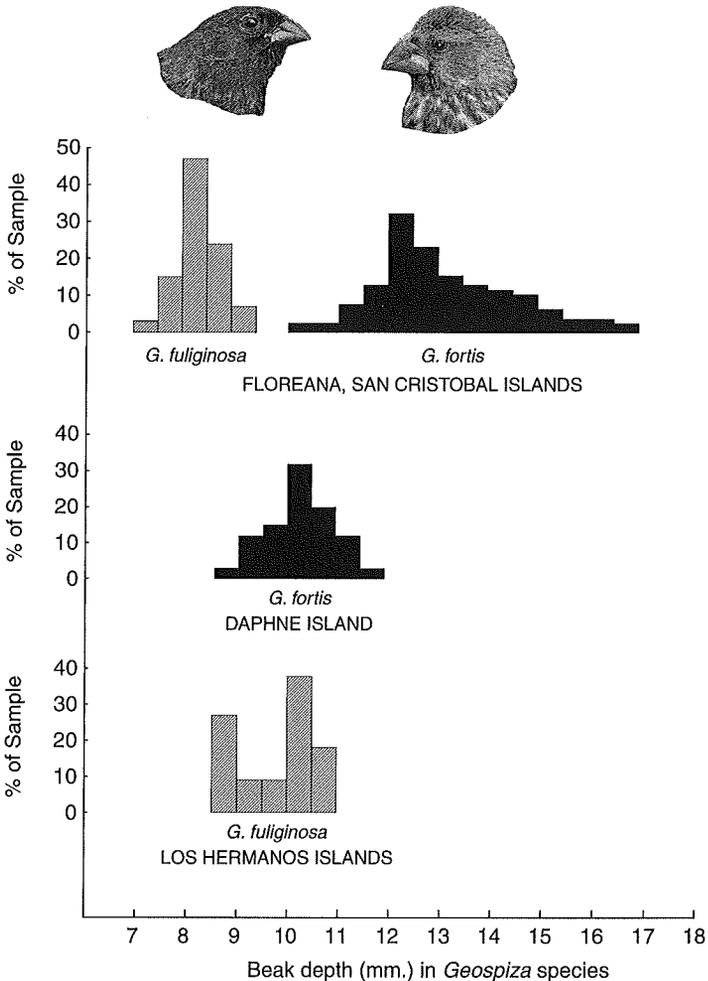


Figure 4.2. Character displacement in Darwin's Galápagos finches.

On Floreana and San Cristóbal islands, where the small ground finch (*Geospiza fuliginosa*) and the medium ground finch (*G. fortis*) are both resident, the two species have distinctly different dimensions for beak depth, which dictates the size of the seeds these species can crack open. On Daphne and Los Hermanos islands, where only one of the two species is present, beak depth is similar, indicating character release. After Lack (1947:82).

speciation and character displacement is adaptive radiation, the evolutionary process that has produced the 14 species of Darwin's finches, the 15 species of Galápagos *Scalesia* (ancestral daisies that have evolved into bushes and 10-meter-high trees), and more than 80 species of Galápagos land snails (Parent, Caccone, & Petren, 2008).

THE BIOLOGY OF SIBLING COMPETITION

Competition is what drives the closely related processes of character displacement and adaptive radiation. Like species, siblings compete over valued resources. On average, among sexually reproducing organisms, siblings share half their genes (unless they are identical twins). In setting forth the concept of kin selection—one of the most important evolutionary insights since Darwin's theory of natural selection—William Hamilton (1964a, b) hypothesized that full siblings will tend to compete for scarce resources whenever the benefits of doing so are more than twice the costs, because it takes two sibs to equal the genetic material that is shared with the self.

From the perspective of Hamilton's theory of kin selection, which involves the tendency for organisms to behave altruistically toward close relatives in proportion to their shared genes, sibling competition and parent-offspring competition are closely linked. Parents are equally related to all of their offspring, and thus have good reason to invest equally in their offspring. By contrast, offspring are twice as related to themselves as they are to their siblings, so ideally they want parents to provide themselves with twice as much investment as the parents give to another sibling. Hence, children are generally in conflict not only with their siblings over the allocation of parental investment, but also with their parents. Children are also in conflict with their parents and siblings over the timing of parental investment (Trivers, 1974). Weaning conflicts exemplify such timing disputes. The unweaned offspring attempts to secure additional parental investment from breast-feeding, which not only gives the offspring greater food resources but also generally delays the conception and birth of a sibling competitor (Figure 4.3).

Sibling competition has been widely documented among animals, birds, fish, and insects (Mock & Parker, 1997; Mock, 2004; Simmons, 2002). Such conflicts are especially prevalent among seabirds and predatory birds and sometimes end in siblicide. Two types of siblicidal competition are observed in nature: obligate (when siblicide almost always occurs) and facultative (when siblicide occurs only under specific individual and ecological conditions). Among Verreaux's eagles (*Aquila verreauxii*), which breed throughout Africa, siblicide is obligate. The elder chick pecks the younger chick to death within the first three days of hatching (Figure 4.4). In species where siblicide is obligate, parents are rarely capable of successfully rearing more than one offspring owing to large food requirements of a single offspring. The second egg, which constitutes a minimal physiological investment by the mother, insures that valuable time is not lost during the breeding cycle if the first egg is infertile or if the older chick dies soon after hatching (Mock, Drummond, & Stinson, 1990).



Figure 4.3. A mother fur seal attacking her older, previously nursing offspring (on the right) while a newborn pup rests on the left. After the birth of a younger sibling, the likelihood that a yearling pup will die increases by about 60 percent. Older pups exhibit aggression toward younger siblings, by biting them and chasing them away from the mother (Trillmich & Wolf, 2008).

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Among seabirds, such as blue-footed boobies (*Sula nebouxi*), parents sometimes successfully rear two or even three chicks, depending on the available food supply. Older chicks are dominant over their younger chicks, limiting their access to food. Siblicidal pecking by the older chick begins only when its body weight drops to about 80 percent of normal. Parents do not intervene in these lethal conflicts, and it is not in their genetic interests to do so (Drummond & García-Chavelas, 1989).

In some species natural selection has engineered specialized traits that help offspring to compete with their siblings. During the tadpole stage, spadefoot toads develop formidable teeth, which they use to cannibalize their broodmates (Bragg, 1954). Similarly, piglets are born with eight “eye teeth” that are later shed. The piglets use these teeth to defend access to the mother’s anterior-most teats, which have the richest supply of milk. By the third week following their birth, mortality among piglets forced to nurse from their mother’s posterior teats is twice the rate for their anterior-nursing littermates



Figure 4.4. A six-day-old Verreaux's eagle chick (top) has opened up a large wound in its one-day-old sibling. In one documented instance, an older Verreaux's eagle chick inflicted 1,569 pecks to the head and body of its younger sibling during the latter's three-day lifespan (Gargett, 1978).

Photograph courtesy of Peter Steyn.

(Trivers, 1985). Even plants engage in sibling competition and have evolved specialized weapons for this task. The India black plum (*Syzygium cumini*) develops seeds with up to 30 ovules. The first ovule to be fertilized secretes a "death chemical" that kills off all the other ovules by preventing them from metabolizing sucrose (Krishnamurthy, Uma Shaanker, & Ganeshiah, 1997). The widespread nature of sibling competition, including its occasional resolution in siblicide, exemplifies a gene's eye view of evolution, as epitomized by Dawkins' (1976) well-known metaphor of the "selfish gene."

SOURCES OF SIBLING DIFFERENCES

Findings From Twin Studies

Just as the study of Darwin's finches has been enriched by recent genetic discoveries (Petren, Grant, & Grant, 1999), behavioral scientists have increasingly drawn on genetic investigations to understand the sources of individual

differences among siblings raised in the same family. Results of these studies, which typically involve comparing identical twins raised together and apart, have turned out to be almost as surprising as Darwin's Galápagos finches were to the zoologists who first examined the birds nearly two centuries ago. By comparing the personalities and intellectual abilities of twins reared under differing conditions, behavioral geneticists have obtained keen insights into the relative contributions of genes and environment in human development.

Typically, behavioral geneticists subdivide the sources of human characteristics into three classes, namely, those stemming from (1) genes, (2) the shared environment (for example, growing up in the same home and living in the same neighborhood), and (3) the nonshared environment (experiences that are unique to each individual—both inside and outside the home). Based on results from numerous twin studies, genetic differences appear to explain about 40 percent of the variance in individual personality. The nonshared environment explains another 35 percent of the variance. By contrast, the shared environment explains only about 5 percent of the variance in personality, leaving the remaining 20 percent of the variance to be explained by errors in measurement (Dunn & Plomin, 1990; Loehlin, 1992; Plomin, DeFries, McClearn, & McGuffin, 2001). The gist of these findings is that siblings are little more alike than people plucked randomly from the general population (Dunn & Plomin, 1990; Plomin & Daniels, 1987).

Why Family Environments Are Rarely Shared

These surprising results from research in behavioral genetics have led some commentators to claim that parents and the family exert almost no influence on personality (Harris, 1998; Pinker, 2002; Rowe, 1994). Although this assertion has received considerable coverage in the popular press—in large part because it goes counter to most people's intuitive assumptions about the family and its influence on offspring—the claim is misleading. The real insight from this behavioral genetic research is not that the family has little influence on personality. Rather, the correct conclusion is that the bulk of the family's influence, including that of parents, is not shared by siblings (Sulloway, 1996; Turkheimer, 2000; Turkheimer & Waldron, 2000).

There are nearly endless ways in which seemingly shared family experiences are not truly shared and prompt siblings to become different. For example, offspring react differently to the same parental behaviors, since every parental action is filtered through a distinctive sibling brain. Parents, in turn, react differently to each of their offspring, because offspring—unless they are identical twins—are themselves genetically different, and are different as well owing to previous environmental influences.

In addition, siblings typically occupy differing niches within the family system. Through differences in these family niches, siblings develop specialized roles based on such factors as age, sex, personality, interests, and ability—all of which cause their daily interactions with parents and other family members to differ. Communal family experiences are never truly shared for another important reason: differences in age cause siblings to experience the same events at different developmental stages (Dunn & Plomin, 1990). In addition, unless offspring happen to be twins, parents are at different ages when their children are born. With each successive child, parents bring differing skills, experiences, marital relationships, and life-stage concerns to their child-rearing efforts.

Much of the support and encouragement that parents give to their children tends to augment differences among their offspring rather than making them more alike. As children are growing up, parents seek to identify useful talents among their offspring and to fine-tune these abilities through instruction and encouragement. Owing to differences in the genetic make-up of each child, some abilities are expressed more strongly in one child than another. For example, parents may help a bold and athletically inclined child to become a figure skater, enhancing this child's prior disposition to take risks. The same parents may encourage a more pensive sibling to pursue an interest in competitive chess, accentuating this child's intellectual orientation. The net consequence of parental shaping is that children become increasingly different as they grow up, a phenomenon that is analogous to Darwin's principle of divergence.

Parents also create differing environments for their children by coercing behavior toward the biosocial norm, as when they seek to inhibit the behavior of a hyperactive child and try to stimulate that of a shy and overly quiescent child (Buss, 1987). Such differing parental responses to offspring reflect what are known as "genotype-environment correlations" (Scarr & McCartney, 1983). These correlations help to explain the fact that, in behavioral genetic studies, seemingly "environmental" influences on behavior frequently contain a genetic component. Three types of genotype-environment correlations have been documented: (1) *passive*, as when an offspring receives from parents a genetic predisposition for higher intelligence, and is also supplied with more books in the home to read; (2) *reactive*, as when parents respond more affectionately toward particularly amiable and affectionate offspring; and (3) *active*, as when offspring with differing genotypes seek out environments that best suit their genetic predispositions. Because all non-twin siblings differ genetically, genotype-environment interactions are continually causing siblings to experience their world—including the family environment—differently.

FIVE MECHANISMS CAUSING SIBLING DIFFERENCES

Research on birth order and family dynamics helps to illuminate the role of the nonshared environment. This research highlights at least five key mechanisms—psychological as well as biological—that cause sibling diversification. These mechanisms include (1) differences in parental investment; (2) dominance hierarchies among siblings; (3) deidentification, or the tendency for siblings to actively seek to differentiate themselves from one another; (4) the closely related principle of niche picking within the family, by which siblings seek different specializations and roles; and (5) birth-order and gender stereotypes, which tend to cause others to react differently to siblings and to assign them specific roles, thereby accentuating disparities (Table 4.1).

DIFFERENCES IN PARENTAL INVESTMENT

Differences in parental investment have been documented prenatally in the amount of nutrition received by the fetus as well as the kinds of hormones in which the fetus is bathed (Sulloway, 2007a). All fraternal twins, and approximately one-third of identical twins, have different chorions, the outermost membrane that envelops the growing embryo and its placenta. As adults, identical twins who have previously shared the same chorion are more similar in their personalities and in some physical attributes (Sokol et al., 1995). Differences in fetal environments also arise as a result of maternal autoimmune reactions to previous male fetuses, which cause sons of higher birth rank to exhibit elevated rates of homosexuality (Blanchard, 2004). Evidence from multiple twin studies suggests that differences in fetal environments explain upwards of 20 percent of the variance in IQ scores (Devlin, Daniels, & Roeder, 1997).

Although parents generally seek to invest equally in offspring after children are born, they nevertheless adjust their investments based on differences in physical and personality characteristics, special needs of offspring, and other factors. Differences in real and perceived prospects for survival and reproduction also affect parental investment. Birth order and gender turn out to be important considerations in this Darwinian calculus. Only two centuries ago, half of all children did not survive past the age of five, and infant mortality rates are still almost this high today in poorer parts of the world. Even small differences in quantity and type of parental investment during childhood can determine which offspring survive and which ones do not.

Table 4.1. A family dynamics model encompassing five developmental mechanisms affecting sibling differences in health, personality, social attitudes, intellectual ability, and strategies to increase Darwinian fitness.

Developmental mechanism	Associated trends in health, personality, and other attributes
1. Disparities in parental investment	Differences in parental investment among offspring occur prenatally as well as postnatally. Prenatally, such differences involve hormones, nutrition, and the health of the mother. Postnatally, differences include the duration of breast-feeding, vaccination rates, verbal stimulation, affection, education, and inheritance. Differences in parental investment influence mortality rates, overall health, closeness to parents, intelligence, personality, and social attitudes.
2. Sibling dominance hierarchy effects	Older siblings are generally dominant over younger ones, and they often use this power to garner more resources within the family. Likewise males and larger children may be more dominant, which affects the nature of sibling interactions and the development of personality.
3. Sibling deidentification	Siblings are often most different from those brothers and sisters who are adjacent in age and birth order. Siblings sometimes vary in the parent to which they are closest, reflecting competitive specialization in the quest for parental affection.
4. Niche partitioning within the family system	Siblings specialize in their family roles. Firstborns are often pressured more by parents to uphold family values and traditions. Surrogate parenting (primarily by firstborns and oldest females) can lead to differences in conscientiousness and other aspects of personality. Laterborn offspring tend to excel in sports, to take greater risks, and to be more unconventional and open to experience.
5. Birth-order, gender, and other stereotypes	Birth-order stereotypes can reinforce birth-order differences. Gender stereotypes, as well as stereotypes based on age and physical size, also influence family roles.

Gender Biases in Parental Investment

Childhood mortality rates vary by sex in ways that promote the reproductive interests of their parents. As Trivers and Willard (1973) realized, natural selection should favor a tendency for adult females to produce male offspring when females are in good physical condition because the healthiest and most robust

male offspring can potentially produce numerous progeny after reaching adulthood. This is especially true when there is intense competition among males for mates, and some males do not mate at all. By contrast, when adult females are in poorer health, they are better off having female offspring, because the physical condition of female offspring is less critical for reproductive success, inasmuch as almost any female can be impregnated by a willing male.

Animals and insects accomplish these adaptive shifts in sex ratios of offspring through physiological mechanisms. Humans achieve similar manipulations of sex ratios through postnatal differences in parental investment (Hrdy, 1999). As Boone (1986) and Volland (1990, 2007) have shown by drawing on large historical samples from Portugal and Germany, the critical factor in the adjustment of sex ratios among humans is not the physical condition of the mother, but rather the social class and wealth of the parents. Among wealthier Portuguese families, for example, sons were more likely to outreproduce daughters, whereas in poorer families, daughters were more likely to outreproduce sons. These and analogous findings implicate differences in parental investment, including the duration of breast-feeding, hygienic care, the provisioning of nutrition and medical care, inheritance practices, and parental resources devoted to dowries (Beise & Volland, 2002; Gaulin & Robbins, 1991; Volland & Dunbar, 1995).

Birth-order Biases in Parental Investment

Relative to younger siblings, older siblings have already experienced more of the childhood diseases that can cause early death. For this reason, older siblings generally represent better Darwinian bets for survival and reproduction and hence should garner even more parental investment (Daly & Wilson, 1988; Rohde et al., 2003; Salmon & Daly, 1998; Sulloway, 1996). Not surprisingly, in societies where infanticide is practiced, no society condones the killing of an older sibling in place of a newborn (Daly & Wilson, 1988).

Accordingly, mortality statistics and other measures of health indicate that parents often invest less in laterborn offspring. Repeated studies have shown that laterborns are less likely to be vaccinated than are their older siblings, with rates of vaccination declining 20-30 percent with each successive birth rank in the family (Hertwig, Davis, & Sulloway, 2002). Lower vaccination rates in turn contribute to the higher childhood mortality that has been documented among laterborn children. Drawing on demographic data from various Latin American countries, Puffer and Serrano (1973) found that compared with firstborns, children of fifth and higher birth ranks experienced two-to-three times the usual rates of infant mortality. In an investigation of 1,903 Philippine households, Horton (1988) determined that younger

siblings, on an age-adjusted basis, were shorter and weighed less than older siblings, indicating poorer nutrition among the younger siblings, who must increasingly subdivide limited parental resources. Similarly, younger daughters tend to reach menarche at a later age than do their older sisters, probably because of poorer nutrition (Surbey, 1998).

Even when they survive childhood, younger siblings often face discrimination by parents in favor of their older siblings. In a survey of 39 non-Western societies, Rosenblatt and Skoogberg (1974) found systematic differences in parental favor by birth order. In these non-Western societies, first children of either sex were generally privileged over their younger siblings through a wide variety of social customs, including birth ceremonies, leadership recognition, and inheritance practices.

In Western and other societies, biases in parental investment have long been manifested in inheritance practices, especially those related to sex and birth order. Going back to the Middle Ages and earlier, the policy of primogeniture—leaving all or most of the property to the eldest son or child—was widely practiced in Europe and other parts of the world to insure the perpetuation of family property and the family name, especially in countries where land was a limited resource (Hrdy & Judge, 1993). In his investigation of the upper nobility in medieval Portugal, Boone (1986) found that younger sons—typically finding themselves landless as a result of primogeniture—were less likely to marry and to leave offspring than were their elder brothers. Among men as well as women, Boone observes, “birth order had a catastrophic effect on the probability of marriage” (1986:869). Landless younger sons were also more likely than eldest sons to take part in the expansionist military campaigns in distant parts of the world, such as Africa and India, where they died in battle or from disease, or where their military service paid off in honors and a share of the spoils of war. This then provided younger sons with an alternative, but highly risk-laden, route to acquiring the resources need for increased Darwinian fitness.

Underinvestment in Middleborns

In their efforts to garner parental investment, middle children are often disadvantaged relative to eldest and youngest siblings. When parents—especially mothers—have passed the age of reproduction, youngest children are the last offspring the parents will ever have. It makes Darwinian sense for parents to invest extra resources in their last, most vulnerable, youngest child. Whereas firstborns tend to receive privileged parental investment based on their greater prospects for survival, and lastborns are favored as well, middle children are left holding the short end of the parental investment

stick (Salmon & Daly, 1998; Sutor & Pillemer, 2007; Sulloway, 1996, 2001). For example, Lindert (1977) documented total child-care hours in 1,296 American families and found that middleborns received about 10 percent less care than either firstborns or lastborns.

Compared with other siblings, middleborns tend to experience less parental investment for another reason. If parents, using an equity heuristic, allocate resources by dividing their resources equally between all existing children, middleborns will end up with fewer resources than other siblings because at all times during their development they must share these resources with other children (Hertwig et al., 2002). By contrast, firstborns receive 100 percent of parental investment as long as they remain only children. After the birth of a second child, both offspring receive 50 percent of total parental investment. With the arrival of a third child, the average amount of parental resources is divided three ways, and investment per child declines to about 33 percent. Eventually, only the lastborn is left at home. Because there usually is never a time when middle children are not sharing parental investment with one or more siblings in the home, middle children seldom reap the advantage that oldest and youngest siblings do when no other children are present. The counterintuitive consequences of parents allocating their resources equally is that middleborns generally receive less cumulative investment than do eldest and lastborn offspring.

Such differences in parental investment may help to explain why middle children are reported to have lower self-esteem than other siblings (Kidwell, 1982) and to be more self-conscious (Chao, 2001; Sulloway, 2001). Perhaps because middleborns typically receive less parental investment, they are not as close to their parents as are firstborns and lastborns. For example, studies have shown that middleborns are generally less likely to turn to parents for emotional support in response to traumatic events (Rohde et al., 2003; Salmon & Daly, 1998). Middleborns also have more positive attitudes toward their friends than do children of other birth ranks; and when they are in monogamous sexual relationships, middleborns are the least likely birth-order group to cheat on a partner (Salmon, 1998, 1999, 2002).

Parental Investment and Intellectual Performance

Considerable evidence indicates that intelligence is positively correlated with parental investment, which is in turn related to the birth order of offspring. Firstborns tend to have higher IQs than their younger siblings, and IQ scores also tend to decline with each increase in birth rank (Belmont & Marolla, 1973; Bjerkedal, Kristensen, Skjeret, & Brevik, 2007; Kristensen & Bjerkedal, 2007; Zajonc & Sulloway, 2007). These differences in intellectual

performance are consistent with the equity heuristic of parental investment as well as with resource-dilution theories (Sulloway, 2007b), including Zajonc's (1976) confluence model, which offers explanations of birth-order differences in IQ in terms of an impoverishment of the family's intellectual environment. The birth of the first child reduces the family's average intellectual environment, and additional children increasingly impoverish this overall environment. According to the confluence model, earlierborn children end up with higher IQs because they spend more time growing up within an environment characterized by frequent interactions with parents. Zajonc's model also includes a role for a "teaching function" by which older siblings tutor younger siblings in their role as surrogate parents, and thus they benefit by developing their intellectual abilities from such teaching efforts.

Parental Investment and Personality

Differences in parental investment, and conflicts with parents over such differences, affect personality. In a multinational study of 6,053 adults who rated themselves and a sibling on personality scales representing all 30 facets of the Five Factor Model, participants who asserted that their parents had favored another sibling tended to score lower on conscientiousness and higher on openness to experience (Sulloway, 2001). Such effects are consistent with a tendency for children who are victims of lower parental investment to identify less with parents' values and to question parental authority (Sulloway, 1996), making it easier for such offspring to break away from parental influence and to explore independent life-course options that may better serve their own interests (Belsky, Steinberg, & Draper; Ellis, 2004; Ellis & Essex, 2007). For offspring who receive lower parental investment, there are often potential benefits associated with the rejection of parental values. Such offspring are less constrained by these values, as well as by possible parental manipulation, and hence they are freer to reject the status quo and to become early adopters of new ideas (Sulloway, 1996). Among immigrant families, offspring who do not share their parents' values have been found to be quicker in their adoption of new cultures and are also more successful, socioeconomically, in such cultures (Manaster, Marcus, & Chan, 1998).

SIBLING DOMINANCE HIERARCHIES

Because siblings differ in age, they also differ in size, power, verbal mastery, and overall maturity. Birth order is correlated with these factors and is a

proxy for them. Close age-spacing, however, diminishes the utility of this proxy, as the closer siblings are in age, the smaller the differences between them. With this qualification in mind, older siblings of both sexes are likely in childhood to be larger, stronger, and more verbally proficient than their younger siblings, and hence to be the "top dogs" of their sibling group. Older siblings are able to employ strategies of dominance that are generally unavailable to younger siblings, who instead must resort to low-power strategies including whining, begging, bargaining, and appealing to parents for protection (Sutton-Smith & Rosenberg, 1970), as well as the positive, low dominance strategies of trying to be supportive, affectionate, cooperative, and cute in order to elicit greater parental investment. Domineering, bossy behavior is typically associated with the family role of firstborns (Beck, Burnet, & Vosper, 2006; Paulhus, Trapnell, & Chen, 1999; Sulloway, 2001).

DEIDENTIFICATION

One of the ways by which siblings differentiate themselves is through a process called "deidentification." This process refers to the tendency for siblings who are adjacent in the family constellation to exhibit opposing personality traits. In a study of siblings' interests and personalities in three-child families, Schachter, Gilutz, Shore, and Adler (1978) found that thirdborns were more similar to firstborns than they were to their next older sibling. Among same-sex pairs of siblings, deidentification was greater than among opposite-sex siblings, for whom rivalry is often reduced by sex-role differentiation.¹ Because of sibling deidentification, birth order trends sometimes exhibit zigzag trends, with each sibling being maximally differentiated in personality from adjacent sibs compared with more distant sibs (Skinner, 1992). Schachter (1982) has also pointed out the phenomenon of split-parent identifications. When one offspring develops a close relationship with one parent, another offspring is likely to develop a close relationship with the other parent. In this manner, siblings avoid intense competition for the affections of the same parent.

Additional evidence for sibling deidentification is provided by longitudinal studies of sibling personalities. Over a ten-year period, Loehlin, Horn, and Willerman (1990) documented negative correlations for personality

¹ Using previously unpublished data from a multinational sample (Sulloway, 2001), I have analyzed the relationship between sibling rivalry (the dependent variable) and birth order, sex, and sex of sibling. None of the main effects were significant, but the interaction effect between sex and sibling's sex was significant ($F_{1, 2,105} = 28.36$, $r_{pb} = .12$, $p < .0001$).

traits among 83 biological siblings. As one child became more introverted over time, for instance, the comparison child tended to become more extraverted. In this same study, negative correlations among the same personality traits were also observed in a larger sample of 312 unrelated children who were reared together as siblings, suggesting that the family environment is pushing children raised together to differentiate themselves.

FAMILY NICHEs

An ecological niche is defined in terms of an organism's adaptive fit with those aspects of its environment that allow it to survive and reproduce more successfully than its competitors. Species living in ecological communities can increase their fitness by evolving so as to minimize competition over the same resources. For instance, the ability to crack open particularly large and hard seeds is part of the adaptive repertoire associated with the ecological niche filled by the large ground finch in the Galápagos Islands. One of Darwin's finches—nicknamed the “vampire finch”—has evolved the unusual behavior of drinking blood from small wounds it creates at the base of the tail feathers of nesting boobies; and another remarkable member of this avian group—the “woodpecker finch”—has evolved the ability to use small twigs and cactus spines as tools to pry insects from crevices in trees (Lack, 1945; Grant & Grant, 2008).

In an analogous fashion, siblings living within the same family tend to develop disparate and complementary roles and adaptations within the family system, thereby creating different “family niches” for themselves in an effort to obtain desired resources. These differing roles and specializations are affected by age and gender, as well as by many other individual differences, including aptitude and life experience. Birth order plays an important part in the development of family niches because it is a proxy for various age-related roles and attributes that are involved in such specializations. Age-spacing between siblings is important in the establishment of family niches because it influences functional birth order, which may not be identical to biological birth order. For example, a secondborn who is separated by a gap of many years from a next older sibling may function like a firstborn or only child (depending on whether additional younger siblings are present in the family). Close spacing also alters the dynamics of birth order, particularly when a younger sibling is bigger and stronger than an older sibling and is able to compete favorably in physical encounters, despite the age difference.

Firstborns often occupy the role of a surrogate parent, assisting parents with child care, and therefore become junior parents. Surrogate parental care by

firstborns often continues in adulthood and may involve economic and other forms of assistance that enhance the fitness of younger siblings (Draper & Hames, 2000). In a study of 1,558 adults living in the Netherlands, Pollet and Nettle (2007) found that firstborns in sibships of three children were twice as likely as were their younger siblings to keep in touch on a weekly basis

Sometimes the role of a surrogate parent falls to a younger sibling rather than the oldest one. Owing to sex-role stereotypes, for example, the surrogate parent role may be thrust upon the eldest female if older children are male, and if there are younger siblings needing child care. Because birth order is only a proxy for differing family niches (together with their associated roles), data about actual family roles is a better predictor of personality than is birth order (Sulloway, 2001). Lacking such specific and possibly overriding information, birth order is nevertheless a useful predictor of the roles likely to have been adopted, and of the individual characteristics likely to have been promoted, because of the particular niches occupied as a consequence of birth order.

Firstborns are usually the first child from among their siblings to attend school. Once they begin school, they seek to maintain parental favor by fulfilling parental standards of responsibility and achievement. Firstborns tend to excel scholastically by becoming the "studious" sibling (Paulhus et al., 1999). Partly as a consequence, firstborns are overrepresented among people listed in *Who's Who*; among American presidents and other world political leaders; and among eminent scientists, including those who have won the Nobel Prize (Altus, 1966; Clark & Rice, 1982; Sulloway, 1996). Seeking a different niche to fill than their older siblings, younger siblings sometimes differentiate themselves by developing abilities in sports. In a large national sample of college freshman that included numerous demographic controls ($N=193,422$), Theroux (1993) found that laterborns were more likely than firstborns to win a varsity letter in high school. Compared with firstborns, younger siblings were also more likely to spend time discussing sports with their friends.

One instructive example of sibling specialization comes from the family of Ralph Nader, the consumer advocate and several-time candidate for president of the United States. When Nader and his three older siblings were adolescents, they divided the world into four equal parts. Each sibling took one quarter of the world, and they subsequently specialized in the history, culture, and languages of his or her own particular portion of the globe. As part of this sibling bargain, Ralph Nader learned three different languages (Chinese, Russian, and Arabic) that were associated with his chosen geographic domain. In accordance with Darwin's principle of divergence, the Nader siblings intuitively understood that they were better off by specializing in different areas of study and then pooling their collective resources

(Sulloway, 1996). This example underscores the fact that within-family divergence and niche picking not only reduce competition, but they also facilitate potentially beneficial cooperation, with siblings profiting from each other's specialties and talents, and with inclusive fitness potentially being enhanced by such cooperation.

BIRTH-ORDER STEREOTYPES

Several different studies have documented the existence of birth-order stereotypes (Baskett, 1985; Herrera, Zajonc, Wiczorkowska, & Cichomski, 2003; Musun-Miller, 1993; Nyman, 1995). Not surprisingly, these stereotypes are similar to differences that are found when siblings rate one another on measures of personality, as many stereotypes are based on commonly observed differences, such as those associated with gender. Firstborns, for example, are generally thought to be more intellectually oriented than laterborns, and they are expected to achieve higher social status. Females are expected to be more nurturing and to invest more in their younger siblings than are their male counterparts. Stronger children are asked to do more physically difficult tasks than are weaker children, and so on. Such stereotypes sometimes influence patterns of parental and sibling investment, thereby transforming cultural expectations into self-fulfilling prophecies that have psychological and even biological consequences, through their influence on fitness.

BIRTH ORDER AND PERSONALITY

More than five hundred studies have been conducted on birth order and its effects on personality. Many of these studies have reached conflicting conclusions, leading some researchers to conclude, wrongly, that the results cancel themselves out and that birth order exerts little influence on personality (Ernst & Angst, 1983; Harris, 1998; Schooler, 1972). One major source of confusion in this extensive published literature involves the large number of studies that contain major confounds because they did not control for social class or sibship size. Large sibships are more prevalent among lower-class families. Hence poorer families are biased for an overrepresentation of laterborns. If a birth-order effect is found in a sample that has not been controlled for social class or sibship size, one cannot be certain that the observed effect is free of the most crucial confounding influences (Ernst & Angst, 1983).

Within-family Studies of Birth Order and Personality

The clearest evidence for birth-order differences in personality comes from studies in which brothers and sisters have made ratings of themselves and the siblings with whom they were raised. This within-family design eliminates any confounding due to between-family differences. Ten such studies using self and sibling ratings, and involving more than 7,000 participants, have assessed personality according to the Five Factor Model. To provide an estimate of mean-weighted effect sizes from these ten studies, I have assessed these findings meta-analytically in Table 4.2. The results reveal that firstborns are rated by themselves and their siblings as being more conscientious than laterborns; and laterborns, compared with firstborns, are rated as being more extraverted, agreeable, and open to experience. The results from these ten studies show significant differences in the magnitude of birth-order effects among the principal dimensions of personality. For example, conscientiousness is more highly correlated with birth order than are the other four dimensions.² These disparities in the magnitude of birth-order effects suggest that niches shaped by birth order exert more influence on some personality characteristics than others.

Birth-order effects in personality exhibit both linear and quadratic trends, with linear trends generally being larger than the quadratic trends for most dimensions of personality (Sulloway, 2001). For this reason, middleborns and lastborns are usually more similar to one another in overall personality characteristics than they are to firstborns. Linear trends are expected based on the dominance-hierarchy hypothesis, as well as from influences that derive from differences in sibling age and size. By contrast, quadratic trends correspond with the hypothesis that middleborns differ from firstborns and lastborns owing to differences in parental investment (Hertwig et al., 2002). In addition, quadratic trends are consistent with the hypothesis that siblings who are closer together in birth rank will seek to differentiate themselves, making those furthest apart in birth rank somewhat more similar in personality.

² Assessments of differences in the magnitude of effect sizes for birth order and personality are based on the procedure of Meng, Rosenthal, and Rubin (1992) for comparing correlated correlation coefficients. For conscientiousness versus extraversion in Table 1, $Z=2.19$, $p=.03$. For conscientiousness versus agreeableness, $Z=3.87$, $p<.001$; for conscientiousness versus openness to experience, $Z=3.44$, $p<.001$; and for openness to experience versus two self-consciousness scales on the dimension of neuroticism, $Z=2.36$, $p=.02$.

Table 4.2. Meta-analytic findings for birth order and the Big Five personality dimensions, based on direct sibling comparisons.^a

Personality dimension	Mean-weighted correlation with birth order ^b	N	p<
CONSCIENTIOUSNESS	-.18	6,208	.0001
Firstborns are achievement oriented, conscientious, hard-working, organized, reliable, responsible, scholastically successful, and self-disciplined.			
EXTRAVERSION^c	.13	5,346	.0001
Laterborns are affectionate, excitement-seeking, extraverted, fun-loving, and sociable.			
OPENNESS TO EXPERIENCE^c	.11	7,218	.0001
Laterborn are attracted by novelty, liberal, prone to fantasy, nonconforming, rebellious, and unconventional.			
AGREEABLENESS^d	.10	5,458	.0001
Laterborns are agreeable, easy-going, modest, submissive (unassertive), tender-minded, and trusting.			
NEUROTICISM	.00	4,704	.93
There are no overall birth-order differences for being anxious, depressed, emotionally stable, self-conscious, and vulnerable.			
(But firstborns are more anxious; and laterborns are more self-conscious.)	(-.06) (.06)	3,346 4,198	.001 .0001

a. Sample sizes for the ten studies included in this meta-analysis are as follows: Beck et al. (2006), N=96; Chao (2001), N=412 to 426 (N varies by personality dimension); Healey & Ellis (2007), N=161 and 174 pairs; Paulhus et al. (1999), N=148, 194, 240, and 369; Rohde et al. (2003), N=1,036; and Sulloway (1999, 2001), N=3,548 to 4,510. The findings of Beck et al. (2006) and Healey and Ellis (2007) are controlled for age-spacing between siblings. The findings of Paulhus et al. (1999) are controlled for sibship size, as are those of Rohde et al. (2003), who also controlled for age-spacing. The findings of Chao (2001) and Sulloway (2001) are controlled for age, age-spacing, sex, sibship size, and social class.

b. A positive point-biserial correlation indicates that laterborns scored higher than firstborns.

c. Firstborns and laterborns are not expected to differ in being "creative," since creativity can be expressed in different ways that exemplify "intellect" (a firstborn trait) as well as "unconventionality" (a laterborn trait). Consistent with this expectation, Paulhus et al. (1999) found a correlation of only .01 between birth order and being "creative." These researchers did not make a prediction regarding the direction of this effect, which, for the same reason, is not included in this meta-analytic review.

d. Beck et al. (2006) classify "dominance" under extraversion. In factor analysis of 30 bipolar adjective pairs chosen to represent the 30 facets of the NEO PI-R Five Factor Model (Costa & McCrae, 1992), Sulloway (2001) found that "assertive (dominant)/unassertive (submissive)" had its highest loading on agreeableness (-.55) rather than on extraversion (.32). The results for this trait are therefore included with agreeableness in this meta-analysis (see also Sulloway, 1996:74).

Between-family Studies of Birth Order and Personality

Results based on between-family studies are generally consistent with those of within-family studies. In a meta-analysis of 188 study outcomes published between 1940 and 1999, significant birth-order trends emerged for all five dimensions of the Five Factor Model of personality, after controlling for differences in sibship size and social class (Sulloway, 1995, 1996, 2002a). Firstborns scored higher than laterborns in conscientiousness, and to a modest degree in neuroticism; and laterborns scored higher than firstborns in agreeableness, extraversion, and openness to experience. Overall, meta-analysis revealed more than five times as many confirming outcomes as opposing outcomes for the Big Five dimensions as a whole. The most consistent differences were those documented for conscientiousness, extraversion, and openness to experience.

Like the findings from within-family studies, between-family outcomes suggest that personality entails an adaptation to the family environment. For example, laterborns seek to discover unique family niches that have not already been taken by older siblings, and hence to obtain greater parental investment through experimentation and risk taking, which together reflect aspects of extraversion and openness to experience (Sulloway, 2001). Risk taking tends to be adaptive whenever organisms, including humans, seek to increase their status in social groups (Ermer, Cosmides, & Tooby, 2008)—including the family group. In addition, the lower a child's likelihood of surviving or reproducing, the more it pays to take risks (Daly & Wilson, 1988). Consistent with these theoretical expectations, studies have shown that laterborns are more likely to have unconventional interests and to take physical risks (Sulloway, 1996, 2001), and, in the domain of mating activities, to have multiple partners and to pursue "short-term" mating strategies (Michalski & Schackelford, 2002; Theroux, 1993).

Perhaps the most studied aspect of birth order and risk taking involves participation in dangerous sports. In a meta-analysis of 8,340 participants in 24 different studies of athletic participation, laterborns were found to be 1.5 times more likely than firstborns to engage in dangerous sports such as rugby, football, and soccer, whereas firstborns and only children preferred safer sports such as swimming, tennis, and track (Sulloway & Zweigenhaft, 2010). This same study analyzed 700 brothers who played Major League baseball since 1876. Younger brothers were 10.6 times more likely than their older brothers to attempt to steal more bases (the odds ratio), and they were also more adept at doing so without being thrown out.

In general, birth-order differences documented in between-family studies are smaller than those found in within-family studies, although experimental manipulations involving between-family samples have sometimes

yielded impressive effects (Courtiol, Raymond, & Faurie, 2009; Salmon, 1998; Sulloway, 2002a). The extent to which birth-order effects transcend the family environment, and the degree to which family-related primes and experimental manipulations can influence such effects in nonfamilial settings, are important topics that deserves further research. What seems clear is that some birth-order differences are predominantly situational, reflecting ongoing rivalry and differing roles within the family system rather than permanent features of personality.

BIRTH ORDER AND SOCIAL ATTITUDES

Birth order is related to social attitudes. In by far the largest study on this subject, which included 193,422 participants and was controlled for sex, sibship size, and social class, Theroux (1993) found that laterborn college freshmen in the United States were more likely than firstborns to endorse what might be characterized as liberal views. Laterborns, for example, were more likely to support legalization of abortion, to oppose laws prohibiting homosexual relationships, and to endorse casual sex. Compared with firstborns, laterborn college freshmen were also less likely to attend church on a regular basis (see also Saroglou & Fiasse, 2003).

Differences in social attitudes by birth order appear to be closely linked with parental identification, which is in turn mediated by parental investment. For example, higher levels of parent–offspring conflict are associated with more liberal social attitudes among offspring, as well as with greater openness to experience (Sulloway, 1996, 2001). In a study of 649 Chinese Tokok families living in Indonesia, Skinner (1992) found that parents systematically favored older siblings by providing them with more of the family's limited resources for education and favorable marriages. At the same time, parents expected older offspring—especially the eldest son—to accept an arranged marriage that benefited the family socially and financially, to provide support for the parents in their old age, to be responsible for commemorative rituals of ancestor worship, and to comply with Confucian ideals about filial obedience and familial responsibility. In turn, older Tokok siblings were found to be more conservative, socially and politically, and more obedient to their parents' wishes, than were their younger siblings.

Such trends linking birth order with social attitudes have also been observed among immigrant families. The process of being absorbed into a new culture can lead parents to pressure offspring—particularly older offspring—to preserve the family's cultural values. In a study of the transmission of social attitudes from parents to 1,042 second-generation Japanese-Americans, Manaster et al. (1998) found that firstborns were more likely

than laterborns to hold onto their Japanese culture. Firstborns, for example, were more likely than their siblings to live in Japanese neighborhoods, espouse Japanese values, place greater importance on religion, and adhere to the Buddhist or Shinto faith of their parents. In the realm of politics, Japanese-American firstborns were 1.4 times more likely than laterborns to vote for conservative political candidates.

In a meta-analysis of 20 previous studies of birth order and social attitudes (Sulloway, 2001), the mean-weighted correlation between birth order and endorsing a liberal viewpoint was .09 ($N=11,240$; controlling sibship size and social class). An effect size of this magnitude is equivalent to laterborns being 20 percent more likely than firstborns to endorse a liberal political position or candidate, which, in the United States, is roughly equivalent to the gender gap in conservative/liberal voting behavior (Clark & Clark, 2008).

Radical Historical Revolutions

In Western history, laterborns have been more likely than their eldest siblings to support radical revolutions. In a survey of 121 historical events, including 28 revolutions in science and more than 90 political revolutions and reform movements, laterborns were generally twice as likely as firstborns to support the radical alternative (Sulloway, 1996, 2002b, 2009). During the Copernican and Darwinian revolutions, for example, younger siblings initiated and supported novel scientific ideas that challenged the literal truth of the Bible. Nicholas Copernicus, who displaced the earth from the center of the solar system and demoted it to just one planet among many, was the youngest of four children. Charles Darwin and Alfred Russel Wallace, who codiscovered the theory of natural selection, were both the fifth of six children (Figure 4.5). Typically, the most vehement opponents of these radical doctrines—such as antievolutionists Louis Agassiz, Georges Cuvier, and William Paley—were firstborns.

Just as laterborns have been more supportive of radical change than firstborns during major innovations in science, they have also tended to endorse radical political upheavals. In a survey of 31 political rebellions taking place over the last four centuries, laterborns proved to be twice as likely as firstborns to back the radical alternative (Sulloway, 1996, 2002b). These findings about laterborn participation in political rebellions are consistent with the results of six within-family studies ($N=2,427$), which asked participants to identify the “rebel” of their sibling group (Chao, 2001; Paulhus et al. 1999; Rohde et al., 2003). Compared with firstborns, laterborns were 1.8 times more likely to be designated as the family rebel, controlling sibship size.

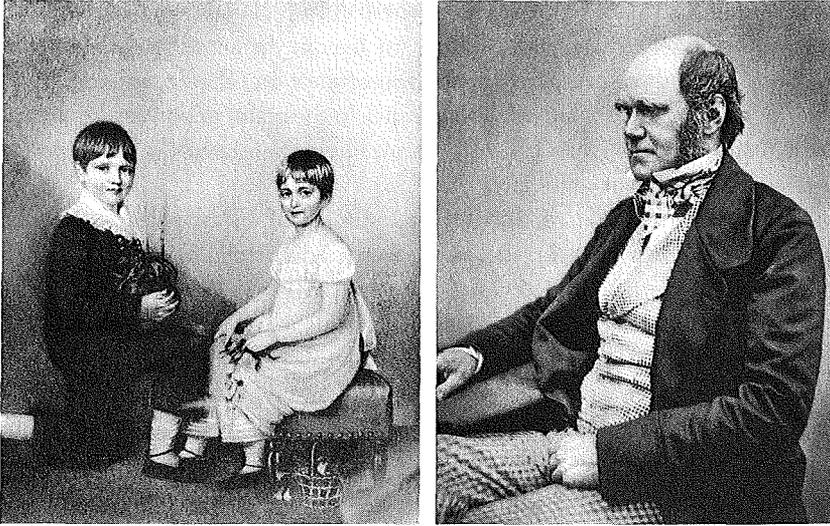


Figure 4.5. *Left:* Darwin (age seven) and his younger sister Catherine, who was the youngest of Darwin's five siblings (from Darwin, 1903, 1: Frontispiece). *Right:* Darwin (ca. 1857), as he was writing the *Origin of Species* (from Seward, 1909: Frontispiece). Darwin's family experience influenced his scientific career in several important ways. Based on a 10-variable logistic regression model, including five variables coding for within-family differences, Darwin's predicted likelihood of endorsing the theory of evolution was 94 percent (compared with more than three hundred other scientists who spoke out on this theory—see Sulloway, 1996). Alfred Russel Wallace, who was politically more liberal than Darwin, was predicted to have a 96 percent likelihood of endorsing this same theory. In this multivariate model, the most significant predictors of support for Darwinian theory were having liberal social attitudes, being laterborn, being young, having experienced extensive conflict with a parent, and having traveled widely, which Darwin and Wallace both did. World travel exposed Darwin and Wallace to potentially fatal accidents and diseases, but it also provided them with compelling evidence of speciation occurring within oceanic archipelagos. This important biological evidence was a major factor in each of their decisions to accept the theory of evolution (Sulloway, 1979).

Historically, the benefits accruing from laterborn risk taking and rebelliousness have been manifested in changing laws that have created greater opportunities for people without inherited wealth. It is not surprising that radical social and political revolutions in Western history have repeatedly targeted the practice of primogeniture and have taken steps to abolish it, as was done by Martin Luther and other leaders of the Protestant Reformation and was also part of the sweeping legal reforms brought about by the French

revolution. Similarly, advocates for the poor, including political activists supporting labor protests, have tended to be laterborns (Sulloway, 1996; Zweigenhaft & Von Ammon, 2000).

Even the Darwinian revolution was not without an implicit ideological message that favored younger siblings. Darwin, for example, wrote about "the evil consequences" of primogeniture in *The Descent of Man* (1871, 1:170); and he once avowed to a colleague: "But oh, what a scheme is primogeniture for destroying natural selection" (1903, 2:34). Similarly, Patrick Matthew, who anticipated the theory of natural selection in 1831, declared that primogeniture was "an outrage on this law of nature [natural selection] which she will not pass unavenged" (Sulloway, 1996:242). Although primogeniture is no longer a common policy in modern societies, this and associated practices that discriminate parental investment by birth order are still observed in less developed societies, especially where wealth is based on land ownership.

A DARWINIAN PERSPECTIVE ON INDIVIDUAL DIFFERENCES

Considering that most children in premodern times did not survive childhood and that many children still die in the poorest countries, the strongest selection pressures in human history have fallen on infants and young children. These pressures involve within-family dynamics, such as differential parental investment, parental manipulation to induce surrogate parental investment by older siblings in younger ones, and various sibling strategies (including role-taking and other aspects of niche-picking) aimed at altering the type, and increasing the amount, of parental investment. These kinds of within-family dynamics are closely linked with the development of sibling differences and are reflective of Darwin's principle of divergence.

In a Darwinian world, sibling competition over parental investment represents a powerful engine of phenotypic novelty, causing siblings to behave differently from one another in their efforts to garner the resources needed for survival and reproductive success. Such differences in personality are analogues of the disparities in morphological traits, such as bill size and shape among birds, that relentlessly drive the evolution of species in nature. Although they are typically modest, the magnitude of the various individual personality differences that are associated with disparities in parental investment, as well as with differences in such factors as birth order and gender, is about the same size as morphological selection differentials found in the rest of nature.³ Such individual personality differences provide a more-than-sufficient basis

³ The mean point-biserial correlation observed for gender differences in personality is approximately .15 (Feingold, 1994; Hyde, 2005; for other within-family

for natural selection to operate on sibling behavior and strategies within the family.

In the course of human development, seemingly small differences early in life can have impressive cumulative effects over the lifespan, including differential reproductive success. For example, based on his or her SAT scores, a firstborn is about 13 percent more likely than secondborn sibling to be admitted to a top college (Sulloway, 2007b). Once admitted to a top college, a firstborn is more likely to be admitted to an elite graduate school, to win a post-doctoral fellowship, and, down the line, to end up being listed in *Who's Who* and other biographical dictionaries devoted to famous achievers (Altus, 1966; Sulloway, 2009). With each crucial step in life, life paths diverge more and more. This is especially obvious where life presents dichotomous outcomes such as being admitted to college or not, or finding a mate or not.

Over siblings' lifetimes, the collective consequences of initially modest differences between brothers and sisters can be substantial. Charles Darwin's remarkable scientific career is a case in point. Like many other contemporary laterborns, Darwin displayed a strong desire to travel to exotic places; and, based on his birth order, his odds of actually doing so were three times greater than for a nineteenth-century firstborn (Sulloway, 1996). Had Darwin not volunteered to go as naturalist on the *Beagle* voyage—an opportunity that arose after his teacher, a firstborn, declined this offer—he would never have visited the Galápagos Islands or encountered the many unusual species that prompted him to develop his theory of evolution. Had he not been more flexible in his religious views than his older sisters, and more intellectually daring and open to experience than his older brother, he might never have generated that controversial theory of evolution by natural selection, which undermined traditional theological beliefs. Like all of us, Darwin's life and career progressed one step at a time in ways that were shaped by earlier experiences within his own family. For Darwin, these developmental experiences played a critical role in his instigation of one of the greatest scientific revolutions in Western history. To that momentous revolution we owe a whole new way of looking at the natural world, including considerably greater insight into the question of why siblings are so different, and how these differences relate to evolutionary fitness.

differences, see Turkheimer & Waldron, 2000). For typical effect sizes associated with rates of natural selection, see Hoekstra et al. (2001) and Kingsolver et al. (2001).

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