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8 Birth Order

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Sibling competition is a common occurrence in the animal world and occasionally ends in siblicide. Birth order often affects the outcome of such struggles because it is a proxy for differences in age, size, power, and access to scarce resources. Among humans, ordinal position is associated with disparities in parental investment, which can lead to differences in behavior, health, and mortality. In addition, siblings in our own species typically occupy disparate niches within the family system and, in mutual competition, generally use different tactics based on age, size, and sex. These alternative strategies and life experiences have effects on personality and also foster differences in attitudes, motivations, and sentiments about the family.

Birth order has long been an important factor in certain social customs and life experiences. These include choice of professions, opportunities for reproduction, emigration decisions, inheritance practices, and rules of royal succession. Ordinal position has also played a role in some social and political transformations. Although a substantial literature has documented a wide variety of birth order effects in health, intellectual performance, and behavior, the magnitude of these effects, and the nature of the domains in which they express themselves, remain sources of scholarly contention. Within the family, the role of birth order appears to be considerable in the expression of personality, social attitudes, and family sentiments. By contrast, in non-familial contexts, these effects are more muted. Moreover, the expression of birth-order effects is often dependent, outside the family milieu, on whether or not certain attitudes and sentiments about the family are tapped in ways that make them salient.

SOURCES OF SIBLING COMPETITION

On average, siblings with the same parents share half their genes. As a consequence, most siblings are twice as related to themselves as they are to one another. Based on this genetic insight, William Hamilton (1964a, 1964b) realized that siblings should compete for scarce resources whenever the gain from doing so is more than half the cost to another sibling. From this cost–benefit perspective, sibling competition and parent–child competition are opposite sides of the same biological coin. Whereas siblings, on average, are only half related to one another, they are fully related to themselves. Parents, however, are equally related to all their biological children. Because of these disparities in biological relatedness, parents will sometimes invest in future children at the expense of current children, a decision that the current children will generally resist.

Weaning conflicts provide a good example of such disputes (Trivers 1974), as do intrauterine conflicts between mother and fetus (Haig 1993). Several life-threatening disorders of pregnancy, including gestational diabetes and preeclampsia, arise as a result of the fetus's efforts to increase the blood supply to the placenta at the expense of the optimal physical condition of the mother. A related set of findings is associated with genetic imprinting (Haig 2004). It is generally in the interests of paternal genes to maximize the mother's contribution to offspring because the mother's future offspring may not be by the same father. Depending on whether or not they are inherited from the mother or the father, the genes that control fetal growth and development may express themselves differently. For example, some paternal genes promote greater fetal size, whereas the same genes, when inherited from the mother, counteract this tendency.

Sibling competition has long been documented among insects, fish, amphibians, birds, and animals (Mock 2004, Mock & Parker 1997). Even plants sometimes exhibit sibling competition. The Indian black plum (*Syzygium cuminii*) produces multiple seeds from the same fruit, which are all botanical siblings. The first of these seeds to be fertilized secretes a "death chemical" that destroys its sibling rivals (Krishnamurthy, Shaanker, & Ganeshaiah 1997). Sibling competition is especially common among birds of prey and among seabirds, and often leads to siblicide. Typically the victim is the youngest member of the brood. Parents make no effort to intervene in such instances, as it is not in their genetic interests to do so.

In some species, particularly birds of prey, siblicide is obligate, meaning that it occurs independently of environmental conditions. In other species, siblicide is facultative, meaning that its occurrence depends on the abundance of food resources available to parents. Among blue-footed boobies (*Sula nebouxii*), siblicide occurs only when the body weight of the elder

chick drops to 80% of normal (Drummond & García-Chevelas 1989). In times of plenty, blue-footed boobies are able to successfully fledge as many as three chicks.

Some passerine bird species regulate parental investment and sibling competition by hormonal means. Female canaries (*Serinus canaria*) lace each successive egg with greater amounts of testosterone. This hormone accelerates neural development and also makes the younger chicks more pugnacious, increasing their ability to compete successfully with their older nest mates (Schwabl 1996; Schwabl, Mock, & Gieg 1997). Depending on the presence of parasitic mites in the nest, female house finches (*Carpodacus mexicanus*) regulate the birth order of their chicks by sex (Badyaev, Hamstra, Oh, & Acevedo Seaman 2006). Male chicks suffer greater mortality from nest mites than do female chicks. In response to mite infestations, breeding females shield their male offspring from parasitism by laying male eggs later than female eggs. Greater allocation of maternal steroids to male eggs accelerates development within the egg, which further reduces exposure to nest mites by allowing males to fledge sooner.

SOCIAL AND ECONOMIC ASPECTS

Like the offspring of other primates, children are heavily dependent on parental investment. For this reason, parental decisions about how to allocate resources among children play an important role in human development. Before the 19th century, childhood illnesses killed half of all children. Parental discrimination by sex and by birth order often determined who lived and who died (Boone 1986; Voland 1988, 1990).

Having survived the most serious illnesses of infancy and early childhood, older children were generally better Darwinian prospects for transmitting their own, and their parents', genes to the next generation. Accordingly, in the premodern period, parents appear to have systematically favored eldest children. As an example, infanticide is widely practiced in traditional societies, but it is invariably the newborn that is killed, not an older infant who is close in age (Daly & Wilson 1988). In non-Western societies, anthropologists have noted that firstborns are generally favored over their younger siblings in a variety of ways—for example, by being given more elaborate birth ceremonies, and by having authority over their siblings in adulthood (Rosenblatt & Skoogberg 1974). Firstborns are also more likely than laterborns to receive the same name as a parent, a practice that is associated with greater parental investment (MacAndrew, King, & Honoroff 2002).

Inheritance customs and practices are sometimes influenced by birth order. Several different systems have been observed. These include

primogeniture (leaving all parental property to the firstborn or to the eldest male), secundogeniture (leaving everything to the secondborn or to the second son), and ultimogeniture (leaving everything to the lastborn or to the youngest son). Local economic and geographical circumstances generally dictate which practice is followed (Hrdy & Judge 1993). For example, primogeniture is frequently practiced when land is a limited resource. By leaving everything to the eldest child or son, parents avoid subdividing the family estate. Ultimogeniture is typically practiced when death taxes represent a heavy burden on estates. Leaving everything to the youngest child or son maximizes the interval before successive taxation. An equal inheritance of parental property has generally been favored in environments where risk taking and skill are associated with economic success. In Renaissance Venice, where fortunes were favored by ability in speculative commerce, parents typically divided their states equally among their children, increasing the chances that multiple children would succeed and that the family name would be perpetuated (Herlihy 1977).

Parental investment according to ordinal position has long been a factor in the professional opportunities and marriage prospects that were available to offspring. Among the nobility in medieval Portugal, birth order had "a catastrophic effect" on the probability of marriage (Boone 1986, p. 869). Compared with their younger siblings, firstborns were nearly four times more likely to marry and to leave children of their own. Because they were frequently unable to marry, laterborns were significantly more likely to have children out of wedlock. Given that landless younger sons represented a threat to political stability, they were systematically sent to faraway lands, such as India, where they participated in military campaigns and often died in battle or from diseases. Some historians have argued that the Crusades were in part a response to the constant political threat posed by these landless younger sons (Duby 1977).

SIBLING DIFFERENCES

Despite the fact that siblings typically share half their genes, parents are frequently struck by how different their children actually are. Studies of twins raised together and apart have shown that about 40% of the variance in personality is genetic in origin, about 35% is explained by the nonshared environment, and only about 5% is attributable to the environment that siblings share as they are growing up within the same family. The remaining 20% of the variance in personality test scores is attributable to errors of measurement (Loehlin 1992, Plomin & Daniels 1987).

These findings have led some commentators to argue that the family has little influence on children (Harris 1998, Pinker 2002). This conclusion,

however, is something of an exaggeration and also fails to appreciate the true nature of family dynamics. To begin with, measurement errors cause a systematic underestimation of the role of the shared family environment. In addition, the role of the family environment is much larger, statistically, than most people realize based on estimates of influence couched as "variance explained." For technical reasons that have to do with the squaring of numbers less than 1.0 to obtain "variance" statistics, small amounts of variance generally represent much more substantial effects than most people realize (Rosenthal & Rosnow 1991, Rosnow & Rosenthal 2003). For example, one of the largest known sources of individual differences in personality is gender, which on average explains 2% of the variance in specific personality traits (Feingold 1994, Hyde 2005). In a medical context, 2% of the variance is equivalent to a drug that increases the odds of surviving a deadly disease by 76%—hardly a negligible effect. New drugs designed to cure potentially fatal illnesses are generally considered newsworthy when they explain just 1% of the variance in treatment outcomes. (A drug that explains 1% of the variance in treatment outcomes is equivalent to a 22% increase in the cure rate and a 49% increase in the odds of being cured.) One of the great triumphs of modern medicine—the Salk vaccine for polio—accounts for only 1/10th of 1% of the variance in post-vaccination outcomes, or about 1/50th of the variance that is associated with the shared family environment and its effects on personality. Expressed in these terms, the shared family environment appears to play a reasonably important role in personality development. By explaining as much as 5% of the variance in personality, this influence is equivalent to a child's having twice the likelihood of being in the top half of the population distribution on a given personality trait—such as being self-disciplined—compared with a child who has not been exposed to the same shared family influence.

The big surprise from behavioral genetics research is the substantial role played by the nonshared environment, which is seven times more influential than the shared environment. One response to these unexpected findings has been to conclude that personality is primarily shaped by peer groups, outside the family of origin (Harris 1998). Although Harris, following Rowe (1994), is fully justified in highlighting the importance of nonshared experiences in personality development, this viewpoint has led to the misleading conclusion that the family itself is relatively unimportant in this process. The family, however, is substantially a nonshared environment, and the bulk of its influence is therefore specific to each child. For example, the same event, such as the death of a grandparent or other family member, occurs when siblings are of different ages and hence is experienced somewhat dissimilarly. Likewise, because offspring are genetically different, they often react disparately to the same behavioral responses from other family members. When such

differences in behavior are manifested by parents, children are particularly sensitive to them (Dunn & Plomin 1990). Seen from this perspective, the most important conclusion from research in behavioral genetics is not that the family exerts little influence on personality but rather that it does so in a considerably different manner than was previously thought, namely, through the nonshared family environment. Expressed in another way, families exert their greatest influence by making children different, not similar.

PSYCHOLOGICAL MECHANISMS

Birth order is one influence among many that helps explain the effects of the nonshared family environment. At least five separate processes are associated with birth order within a family dynamics model: (1) differences in parental investment; (2) sibling dominance hierarchies; (3) niche specialization; (4) deidentification, or the tendency for siblings to strive to be different from one another; and (5) sibling stereotypes.

Parental Investment

Typically, differences in parental investment cause quadratic or U-shaped distributions in resources, with middleborns receiving fewer resources than firstborns or lastborns. Such U-shaped distributions result in part from what has been termed the "equity heuristic" and its counterintuitive consequences (Hertwig, Davis, & Sulloway 2002). The equity heuristic is a variant of resource-dilution theories and refers to the tendency for parents, in modern societies where resources are relatively abundant, to treat their children equally. Unlike middleborns, firstborns and lastborns experience a period in which they are the only children living at home. As a consequence, the cumulative investment they receive from parents is greater than that allotted to middleborns, who generally obtain an equal share of resources divided among all the children who are present within the home. When a particular parental resource is allocated in childhood, such as financial resources for vaccinations, the equity heuristic predicts linear birth order trends in which firstborns are favored over their younger siblings. This is because younger children cannot equalize the acquisition of such resources at a later age, when older siblings have finally left the home, given that these resources are no longer developmentally relevant.

In contrast to middleborns, lastborns benefit from another tendency in parental investment. As mothers reach the end of the reproductive careers, youngest children increasingly become the last child they will ever bear. Under

such circumstances, it is adaptive for parents to invest greater resources in youngest children, especially during the vulnerable stages of infancy and early childhood, because these offspring cannot be replaced (Rohde et al. 2003, Salmon & Daly 1998). The tendency for parents to favor lastborns augments the typical U-shaped distributions that result from parents' allocating resources according to the equity heuristic. In short, the only way for parents to be truly equitable to offspring on a cumulative basis is for them to systematically favor middleborns—something that other offspring would not readily tolerate.

A variety of studies underscore these theoretical perspectives on birth order and parental investment. In one noteworthy study, Lindert (1977) tracked the total number of childcare hours devoted by parents to their children up to the age of 18. In families with two or more children, middleborns typically received 10% less childcare than did firstborns or lastborns. In a study of 1,903 children living in the Philippines, Horton (1988) found that laterborns received less nourishment than firstborns, as assessed by children's height and weight. Other studies have shown that the likelihood of being vaccinated declines by 20–30% with each successive child within the family (Hertwig et al. 2002). Such differences in nourishment and healthcare appear to be directly related to mortality. In a study of 14,192 Swedish children, third- and fourthborns were 2.1 times more likely than firstborns to die before the age of 10 (Modin 2002).

Sibling Dominance Hierarchies

Siblings create dominance hierarchies based on age, size, and power. Both physically and verbally, firstborns can easily intimidate their younger brothers and sisters. As a result, they usually exert dominance over their siblings. Several aspects of personality and behavior, as expressed within the family, reflect these differences in position within sibling dominance hierarchies (see below, under Behavior and Personality).

Family Niches

Sibling differences arise in part because of the different roles that children adopt within the family system. These differing roles are fostered by genetic disparities, and also by differences in sex and birth order. The resulting diversification of family roles exemplifies Darwin's (1859) famous "principle of divergence." As with competing species in nature, role specialization among children leads to a division of labor and reduces competition. Specialization also makes it harder for parents to compare the abilities of one child against those of another

(which generally benefits younger and less-experienced offspring). Darwin's principle of divergence is one of the most important principles of evolutionary biology; it explains the phenomenon of "adaptive radiation" among closely related species, as with his famous Galápagos finches (Grant 1999; Kleindorfer, Chapman, Winkler, & Sulloway 2006). Ordinal position within the family is directly relevant to this process of sibling diversification because birth rank is inextricably linked with age and hence with opportunities for children to engage in age-specific tasks. Because of their greater age, for example, firstborns tend to occupy the niche of a surrogate parent, leading them to develop a sense of parent-like responsibility and to emulate other adult behaviors.

Deidentification

Siblings often strive to differentiate themselves from one another, a process that has been called "deidentification" (Schachter, Gilutz, Shore, & Adler 1978). This process extends to patterns of identification with, and attachment to, parents. If one child prefers one parent, for example, another child will often identify more closely with the other parent (Rohde et al. 2003, Schachter 1982). Such patterns of deidentification are expected to produce zigzag trends because each child seeks to maximize the process of differentiation from his or her closest siblings in age (Skinner 1992).

Birth-order Stereotypes

Stereotypes associated with ordinal position appear to reinforce, and perhaps to foster, some of the behavioral differences observed among siblings. Stereotypes generally build upon real differences that are widely observed and culturally sanctioned. Such stereotypes are well documented in the literature on birth order (Baskett 1985, Musun-Miller 1993, Nyman 1995). It is generally believed, for example, that firstborns tend to be more intellectually oriented than their younger siblings, are more conscientious in their work habits and studies, and attain higher levels of professional status in life. These stereotypes correspond closely with observed differences by birth order (Herrera, Zajonc, Wieczorkowska, & Cichomski 2003).

BEHAVIOR AND PERSONALITY

More than 2,000 publications have dealt with birth order and its effects on human behavior and intellectual performance. Unfortunately, most of these studies are not controlled for differences in important background

influences, such as social class and family size. As Ernst and Angst (1983) have noted, lower class families are biased for large sibships. Hence, a study that is not controlled for social class or sibship size and that reports a birth-order difference for some attribute may simply have detected a spurious cross-correlation with socioeconomic or other background factors. Nevertheless, when well-controlled studies are examined and subjected to meta-analysis—a technique for amalgamating study results to reduce statistical error—modest but consistent trends do emerge in birth-order research (Sulloway 1995, 2000, 2002b).

Personality, and much of human behavior more generally, can be usefully classified in terms of five dimensions—often called the "Big Five" (Costa & McCrae 1992, McCrae & John 1992). Within this five-factor model of personality, the salient dimensions are conscientiousness, agreeableness, extraversion, openness to experience, and neuroticism. When assessed in terms of these five dimensions, the cumulative research on birth order and personality is reasonably consistent with predictions based on a family-dynamics model.

In within-family studies (which need to be distinguished methodologically from between-family studies), firstborns generally score higher in most aspects of conscientiousness. Firstborns are rated by both parents and siblings as being more self-disciplined, organized, and deliberate than their younger brothers and sisters. They are also considered the "achievers" of the family (Healey & Ellis, 2007; Paulhus, Trapnell, & Chen 1999; Plowman 2005; Sulloway 1996, 1999, 2001). These consistent findings strongly suggest that firstborns experience a different family environment than do laterborns. For example, firstborns often occupy the role of a surrogate parent, a family niche that tends to ingratiate them with parents as the "responsible" child. Owing to their relative immaturity, laterborns are generally unsuited for the role of a surrogate parent and must seek parental favor by other means—for instance, through athletic ability or by developing other latent abilities.

Again, in within-family studies, laterborns score higher than firstborns on most aspects of agreeableness (Paulhus et al. 1999; Sulloway 1999, 2001). Firstborns can readily avail themselves of greater physical size to achieve dominance over their younger siblings. By contrast, laterborns tend to employ low-power strategies to obtain what they want. These strategies include pleading, bargaining, and, when all else fails, appealing to parents for protection and assistance. The unusual status of middleborns—sandwiched as they are between firstborns, who have greater status and physical power, and lastborns, who are protected by parents—may explain why middleborns are typically rated higher than their siblings on most measures of agreeableness.

On the Big Five dimensions of extraversion, there are distinctly heterogeneous results by birth order (Sulloway 2001). Firstborns are rated as being more dominant and assertive than laterborns. By contrast, laterborns are rated as being more fun-loving, affectionate, and drawn to risk taking and excitement. More often than their elder siblings, laterborns also seem to use humor as a strategy and sometimes cultivate the role of family comedian.

The attributes of openness to experience, like those of extraversion, exhibit a high degree of heterogeneity, or diversity, in within-family studies. Firstborns score higher on those measures of this personality dimension that tap intelligence and intellectual orientation. Laterborns score higher on those measures that tap imagination, attraction to novelty, and rejection of tradition. When asked in one study to list various "unconventional" aspects of their lives, laterborns offered significantly more examples of such behaviors and interests, as evaluated by two independent judges (Sulloway 2001). Similarly, Paulhus et al. (1999) found that laterborns were twice as likely as firstborns to describe themselves as "the rebel" of the family. Rohde et al. (2003) obtained a nearly identical odds ratio (1.8:1) in another within-family study that included samples from Israel, Norway, Russia, and Spain. In a study involving participants from Australia, Healey and Ellis (2007) found that laterborns were more "rebellious," "nonconformist," and "open to experience" ($r = .19$, which translates to an odds ratio of 1.8 to 1).

Differences in neuroticism by ordinal position tend to be small. This is expected because many neurotic traits do not appear to be adaptive in the context of a family-dynamics model of personality, and most birth-order differences are expected to serve adaptive functions, either in mutual sibling competition or in optimizing parental investment. One consistent finding, however, is noteworthy: laterborns—particularly middle children—display lower self-esteem than other siblings (Kidwell 1982). This finding may relate to observed birth-order differences in parental investment.

Most birth-order effects appear to be environmental in origin. This conclusion follows from the fact that there are no genes for being a firstborn or a laterborn. Nevertheless, the intrauterine environment is known to foster at least one birth-order difference. Among brothers, later birth order is correlated with an increased tendency toward homosexuality (Blanchard 2004). This well-replicated finding is consistent with the hypothesis that, during pregnancy, some mothers develop antibodies to antigens of the male-specific histocompatibility complex. These antibodies appear to interfere with the masculinization of successive fetuses, causing laterborns to exhibit a 33% increase in homosexuality for each older brother present in the family.

In assessing birth-order differences in human behavior, it is important to distinguish between functional and biological birth order. A large gap in age between a firstborn and an immediately younger sibling can create functional

"only children" of both siblings. Only children need to be distinguished psychologically from children of other birth orders. They represent a controlled experiment in birth-order research because they experience childhood without the effects of either sibling rivalry or sibling dominance hierarchies. For this reason, only children tend to be intermediate between firstborns and laterborns on most aspects of personality. Because they have no siblings and tend to identify closely with their parents, only children do resemble firstborns in attributes that are related to conscientiousness, including the attainment of high levels of intellectual achievement. Some of the distinguishing features of only children, such as greater educational attainment, also relate to the economic benefits of growing up in small families.

Because age spacing mediates the effects of birth order, these effects vary considerably in their degree of expression. In general, an age gap of 2 to 4 years produces the largest birth-order effects. In a carefully designed study that controlled for social class, sibship size, and other variables, Helen Koch (1955, 1956) documented numerous moderating effects on personality and intellectual performance that were related to age separation, sex, and sex of sibling. These effects, which often involved two- and three-way interactions, underscore some of the ways in which the family environment is not shared by siblings.

CRITICAL METHODOLOGICAL ISSUES

Birth-order differences in personality and behavior are most prevalent in studies in which parents evaluate their own children, or siblings rate one another (Ernst & Angst 1983; Healey & Ellis, 2007; Paulhus et al. 1999; Sulloway 1999, 2001, 2002b). In this class of studies, birth order explains 1–2% of the variance in individual dimensions of the five-factor model of personality.

Within-family studies of birth order and personality may overestimate effect sizes for some traits and behaviors. For example, within-family studies appear to involve "contrast effects" or a tendency for parents and children to magnify true differences in rendering such comparisons (Saudino 1997). For some attributes, within-family studies may also confuse differences in personality with differences in family roles. Firstborns, for example, may be rated as being more "conscientious" than their younger siblings because the role of a surrogate parent generally falls to them, together with the behavioral attributes that go with this "responsible" role.

A particularly important question involves the manifestation of birth-order effects outside the family. When subjects taking standard personality tests are asked to rate themselves without reference to a sibling, birth-order effects are usually small and often not significant (Ernst &

Angst 1983; Harris 1998; Jefferson, Herbst, & McCrae 1998; Parker 1998). Such findings may be contrasted, however, with the modest but consistent differences by birth order that are obtained when spouses and roommates evaluate one another, and also the differences found in studies involving real-life behaviors as opposed to self-ratings of personality (Sulloway 2001, 2002b). In these types of studies, birth-order effects are about one-third to one-half the magnitude typically reported in within-family studies. Even more noteworthy is the fact that birth-order effects documented in extrafamilial studies correlate strongly (r = .65) with effects for the same traits reported using direct sibling comparisons. This meta-analytic finding suggests a high degree of continuity in behavior, even if the magnitude of such effects is generally reduced in nonfamilial settings.

A few examples of such consistent behavioral continuity may be cited here. Firstborns are typically overrepresented on standard measures of social and intellectual achievement, such as being world leaders, being listed in *Who's Who,* and receiving prestigious awards for their scientific or literary accomplishments (Altus 1966, Clark & Rice 1982, Sulloway 1996). In adulthood, firstborns also score slightly higher than laterborns on standard intelligence tests—IQ declines about 1 point with each successive birth rank in the family (Belmont & Marolla 1973). These differences in intellectual performance appear to reflect a dilution of parental resources associated with increased family size. As new children are added to the family, parents have less time and financial resources to devote to each child. In addition, each successive newborn dilutes the family's average intellectual environment, causing a reduction in IQ among children raised in large families (Zajonc 1976, Zajonc & Mullally 1997).

Differences in intellectual performance by birth order do not always show up in carefully designed studies involving siblings from the same family. These null findings have led some researchers to dismiss the importance of birth order (Wichman, Rodgers, & MacCallum 2006). Such null results, however, are generally confined to studies of young children, before the developmental effects of birth order have fully manifested themselves. According to Zajonc's (1976) "confluence model" of intellectual performance, when children are at the same age, laterborns actually experience a richer intellectual environment than do their elder siblings because the presence of elder siblings helps enrich that environment. Firstborns, however, steadily benefit from being able to teach what they know to younger siblings and from aspiring to fulfill parental expectations, such as doing well at school. The net result of these contrasting influences is that firstborns begin to score higher than their younger siblings by the time they reach adolescence (Zajonc & Sulloway in press).

Another behavioral domain in which birth-order effects have been documented in nonfamilial studies involves risk taking and excitement seeking, which are closely related to the Big Five dimension of extraversion. In one well-designed study of Columbia University students (N = 1,967), laterborns were 1.6 times more likely than firstborns to participate in dangerous sports such as rugby, football, and soccer (Nisbett 1968). These findings may also reflect a tendency for laterborns to avoid athletic competition with accomplished older siblings who have already adopted safer sports such as swimming, tennis, and basketball.

Birth-order differences in risk taking have been documented in several other behavioral domains. In a historical study of scientists and explorers, Sulloway (1996) found that laterborns were significantly more likely than firstborns to travel to remote parts of the globe, where they ran a greater risk of dying from accidents or contracting life-threatening diseases. Such was the fate of Alfred Russel Wallace, who co-discovered the theory of natural selection while recovering from a malarial fit in faraway Malaysia. Charles Darwin risked death several times during the *Beagle* voyage. He may also have acquired a debilitating parasitic disease during his 5-year voyage around the world.

In the course of history, laterborns have generally been more likely than firstborns to challenge the status quo (Sulloway 1996). During the Protestant Reformation, younger siblings were more supportive than their elder siblings of calls for church reforms, including the abolition of celibacy among priests and nuns. This particular policy directly benefited younger siblings, who were systematically shunted into the clergy under the reigning system of primogeniture and hence were less likely to marry and have children of their own (Boone 1986). Leading Protestants also proclaimed the principle of primogeniture to be "unchristian" and urged political rulers to let their sons share in royal succession through partible inheritance of principalities.

Throughout Western history, many political revolutions have been championed by younger siblings, including such political leaders as Georges-Jacques Danton, Vladimir Lenin, Leon Trotsky, Fidel Castro, and Ho Chi Minh (Boone 1986; Sulloway 1996, 2000, 2002a). There is also evidence that middleborn revolutionaries differ from other political radicals in preferring nonviolent means of political transformation, which accords with within-family findings about birth-order differences in agreeableness. During the French Revolution, for example, middleborn deputies to the National Convention were more likely than their colleagues to oppose the extreme measures that led to the Reign of Terror.

Within the field of science, radical revolutions have generally been led and supported by laterborns (Sulloway 1996, 2000; Numbers 1998).

"Radical" revolutions may be defined as those having important religious or political implications, engendering widespread public debate outside the scientific community, and/or taking many years to resolve. The most notable leaders of radical scientific revolutions have included Nicholas Copernicus (the youngest of four children), Francis Bacon (the youngest of eight), René Descartes (the youngest of three), Charles Darwin and Alfred Russel Wallace (both the fifth of six), and Werner Heisenberg (the middle of three).

Firstborn scientists have also led a variety of important conceptual revolutions. These particular scientific transformations have tended to be more technical and less ideologically charged than the kinds of radical revolutions endorsed by laterborn scientists such as Copernicus and Darwin. Famous firstborn revolutionaries include Johannes Kepler, Galileo, William Harvey, Isaac Newton, Antoine Lavoisier, Charles Lyell, and Albert Einstein. Many firstborn revolutionaries have benefited from other influences that are known to promote openness to experience. Compared with firstborn scientists who have opposed new scientific ideas, those firstborns who have led revolutions have tended to be significantly younger, to be more socially liberal, and to have experienced higher levels of conflict with one or both parents. Independently of birth order, these three influences are substantial predictors of support for radical revolutions.

Although the role of birth order in radical revolutions may have drawn some of its strength from the prior practice of primogeniture, contemporary evidence has confirmed historical findings. In a study of middle-aged Canadian subjects, Salmon and Daly (1998) asked: "Do you think that you are open to new and radical ideas (such as cold fusion)?" Controlled for age, sex, and sibship size, laterborns were 2.3 times more likely than firstborns to claim that they would be open to such novel ideas. In a study that was controlled for sibship size, Zweigenhaft and Von Ammon (2000) found that laterborns were 2.2 times more likely than firstborns to undergo multiple arrests at a strike for better working conditions at a Kmart in Greensboro, North Carolina.

In contrast to these supporting studies, Freese, Powell, and Steelman (1999) analyzed social and political attitudes among subjects included in the General Social Survey. They found only 3 significant differences out of 33 measures. In addition, all 3 findings were opposite to the direction predicted. In spite of such inconsistent findings, a meta-analysis of 20 studies of social attitudes that are controlled for sibship size (at a minimum) reveals a modest but consistent trend for laterborns to endorse the liberal or radical alternative (r=.09, N=11,240). It is also noteworthy that when these 20 studies were independently rated on a scale of personal and emotional involvement, the reported effect sizes were significantly larger for studies that entailed a high

degree of involvement, such as real-life episodes of conflict, as opposed to responses on paper-and-pencil tests (Sulloway 2001).

SITUATION-SPECIFIC BEHAVIOR

Although much of personality is consistent from one situation to another, a substantial part of human behavior is sensitive to behavioral contexts and hence is consistent only within the same contexts (Cervone & Shoda 1999). The collective literature on birth order and human behavior accords with this situational perspective: such differences express themselves in their fullest form only when situations trigger responses that draw on patterns of behavior learned within the family.

Only a few studies have specifically sought to test the role of situation-specific tendencies as they relate to birth order. One example is provided by Salmon (1998), who played an electronically recorded campaign speech to 112 university students. In an effort to evoke latent family sentiments, Salmon created one version of the speech containing political appeals to "brothers," "sisters," and "brethren." A second version of the speech replaced these family-related references with appeals to "friends." Salmon predicted that firstborns and lastborns, who typically receive greater parental investment, would prefer the political speech containing family-related language, whereas middleborns were expected to favor the version containing references to friends. These predictions were confirmed. In another study, Salmon and Daly (1998) found that middleborns were significantly underrepresented in a sample of 236 adult genealogical researchers. In addition, these two researchers found that middleborns were less likely than other children to name a parent as the person to whom they were closest, and were less likely to seek comfort from a parent during times of emotional upset. These findings have been replicated by Rohde et al. (2003).

Such studies strongly suggest that birth-order effects indeed manifest themselves outside the family milieu when the behavioral context provides a direct tie with latent familial sentiments or patterns of identification. In this connection, it would be helpful to know more about childhood preferences for certain family niches and how these preferences influence the roles people adopt as adults within the new families they create for themselves. We also need to know more about the specific psychological processes that are involved when behaviors learned within the family express themselves in other nonfamilial contexts. Recent research on the relational nature of the self, together with social–cognitive models of transference, may help fill this gap (Chen, Boucher, & Tapias 2006).

EVOLUTIONARY ASPECTS OF FAMILY DYNAMICS

Ordinal position is just one influence among many that contributes to family dynamics and its influence on human development. In attempting to elucidate the multiple sources of the nonshared family environment, behavioral scientists continue to face a considerable challenge. Given the substantial role played by genetic factors, behavioral genetics models have become an important methodological tool in studies of human development. Such models, however, do not directly analyze the nonshared environment. Rather, they infer its influence from the statistical variance that remains unexplained after assessing the influence of shared genes and shared environments. A major challenge for the future is to begin to disentangle the relative contribution of the nonshared family environment from the overall nonshared environment (McGuire 2001; Plomin, Asbury, & Dunn 2001; Turkheimer 2004; Turkheimer & Waldron 2000). Given the amount of time that children spend interacting with their parents and siblings, it would not be surprising if a substantial portion of the variance in behavior that is attributable to the nonshared environment owes its origins to within-family differences. A reasonable estimate is that the family may explain a third to a half of this variance, or about 12 to 18% of the overall variance in human personality. Combined with the influence of the shared family environment, which explains another 5% of the variance, an effect of this magnitude would be at least eight times greater than that represented by gender differences. It would also be equivalent to an influence that, at a minimum, quadruples one's likelihood of developing a particular personality trait.

From a Darwinian perspective on human behavior, it should come as no surprise that behavioral dispositions first acquired within the family are expressed only conditionally in adulthood. Human behavior and personality exemplify a host of cumulative adaptations to life as it is experienced within, and later beyond, the family of origin. Over the millennia, natural selection has fine-tuned such context-sensitive responses to the adaptive problems people face. As adults, we do not treat strangers or friends in the same way that we treat family members. Strategies for getting along with other family members that we originally learned as children provide a behavioral toolkit that we continually modify and update as we interact with other people over our lifespan. We draw from this evolving toolkit as needed but only when specific behavioral responses are appropriate to the situation.

In spite of the many questions that remain about the role of birth order and family dynamics in human development, one general conclusion bears special emphasis. The origins of personality, social attitudes, and behavior—and their evolving expressions in the course of human development—are

more complex than most researchers believed just a few decades ago. Individual influences, such as birth order and gender, appear to play more-restrictive roles than was once thought, and the roles they do play are more nuanced. Nevertheless, within this revised and increasingly interactionist perspective on human development, an evolutionary approach continues to identify birth order and sibling competition as fruitful subjects for future research.

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