out of their current state of crisis and disarray. Unlike most alternate maps, however, the evolutionary map is etched in a sound and comprehensive theoretical base, and it gives the traveler clear directions about how to eventually arrive at a fuller understanding of human behavior. No other theoretical perspective currently holds such promise.

Note

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Birth Order and Evolutionary Psychology: A Meta-Analytic Overview

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"Bit-Part" in a Darwinian Drama?

It has been more than 20 years since Schooler (1972) published his damning review of the birth-order literature under the provocative title, "Birth Order Effects: Not Here, Not Now!" Since then, several reputable scholars have reached the same conclusion: Birth-order effects are a mirage. Ernst and Angst (1983), in their exhaustive review of the world literature from 1946 to 1980, concluded that such effects are artifacts of poor research design. By failing to control for obvious background factors, such as family size and social class, researchers confuse differences in personality owing to social background with differences caused by birth order. Thus, upper-class families are biased for small sibships, which are in turn biased for firstborns. According to Ernst and Angst, studies that fail to control for social background consistently report birth-order effects, whereas those employing appropriate controls do not. Ernst and Angst concluded their monumental study of more than 1,000 publications on this subject with the statement: "*Birth order influences on personality and IQ have been widely overrated*" (p. 242). Other careful scholars, working with independent data, have agreed. For example, Dunn and Plomin (1990) asserted, from the vantage point of behavioral genetics, that birth order "plays only a bit-part in the drama of sibling differences" (p. 85). Similar conclusions have been reached by Blake (1989), Plomin and Daniels (1987), and Scarr and Grajek (1982).

Four Darwinian Conflicts

Buss's thoughtful and programmatic justification for the field of evolutionary psychology strongly suggests that such sweeping dismissals of the birth-order literature are mistaken. The centrality of birth order to human psychological development is virtually demanded by the Darwinian logic that Buss presents in his target

article. Birth-order differences, Buss specifically notes, involve just the kinds of "recurrent adaptive problems" that should foster individual differences. This logic merits further discussion.

The case for birth order resides in the relatively small number of fundamental conflicts that Darwinian theory predicts for human behavior. At least three forms of conflict have been widely recognized. Darwin (1859) identified *sexual selection* as the outcome of same-sex conflicts over mates. Recognition of the second conflict is due to Williams (1966) and Trivers (1972), who appreciated the Darwinian implications of *differential parental investment by the sexes.* As Buss has ably demonstrated, in large part through his own research, these two Darwinian conflicts provide a crucial foundation for understanding human mating strategies.

Trivers (1974) dubbed the third great Darwinian struggle *parent–offspring conflict.* Because parents are only 50% related to their offspring, there will be conflicts over the degree of parental investment, as manifested in such phenomena as weaning. Implicit in this third Darwinian conflict is a fourth conflict, which has not received as much recognition—perhaps for lack of a formal label. This fourth conflict of Darwinian interests is *sibling–sibling conflict.* Because siblings share only half their genes, they will sometimes differ with parents in deciding how resources should be allocated among fellow siblings. Whereas parents will encourage equal sharing among their offspring, to whom they are equally related, siblings will generally prefer to retain twice as much of any scarce resource as they share with a sibling. Altruism among siblings has its limits. It should be noted that parent–offspring conflict would be far, far less if sibling conflict were not there to drive it. Indeed, parent–offspring conflict largely depends on sibling conflict, even if the "rival" sibling is only prospective. This foursome of "Darwinian discontents" appears to add one more to the list of "middle-level evolutionary theories" that Buss outlines in his article.

Sibling conflict is driven by another Darwinian consideration that has received less attention in the literature. In the early evolutionary environment, older siblings would have had considerably greater reproductive value to parents. As Daly and Wilson (1988, pp. 72–73) pointed out in a perceptive analysis of this problem, parents should generally value older children more than they do younger children. With childhood mortality rates of around 50% in the early evolutionary environment, older children have always contributed more to their parents' inclusive fitness. Given the high infant mortality of the first years of life, the reproductive disparity between older and younger siblings can be striking. For example, a 4-year-old in a typical hunter-gatherer society possesses roughly 1.4 times the reproductive value of a newborn, who is generally facing a 20% mortality rate in the first year of life alone (Daly & Wilson, 1988, p. 41). An 8-year-old possesses 1.5 times the reproductive value of a newborn. By the time our hypothetical firstborn has reached the age of 12 years, this individual possesses 1.7 times the reproductive value of any newborn sibling. Even if this newborn survives to reproduce, the valuation-gap between itself and its older siblings is never fully closed. The eldest child will generally be the first to reproduce and hence to have grandchildren. As Daly and Wilson (1988) noted in their survey of 60 cultures included in the Human Relations Area Files, many societies regularly practice infanticide when resources are scarce or when siblings are too closely spaced. There is not a single culture that calls for the sacrifice of older siblings!

Darwinian Strategies for Siblings

From a Darwinian perspective, parents should continually make discriminations about the reproductive value of their children (Daly & Wilson, 1988, p. 42). It is difficult to imagine that siblings do not respond in strategic ways. If birth order indeed plays only a bit-part in the drama of sibling differences, evolutionary psychology will have failed to prove itself in an important Darwinian domain. This failure would be all the more discouraging because birth-order differences represent a major potential source of explanation for individual differences. Abundant research has shown that siblings raised together are enormously different from one another—almost as different as people plucked randomly from the general population (Plomin & Daniels, 1987). Owing to "contrast effects," siblings differ from one another precisely because they have grown up together (Loehlin, 1992, p. 101; Schachter, 1982). As Buss emphasizes, explaining individual differences has proved to be one of the most recalcitrant problems within evolutionary psychology. If something so fundamental as sibling differences are not explicable within a Darwinian approach, it is difficult to imagine that other individual differences will turn out to be so. Birth order is the single most obvious factor that makes the shared family environment different for each sibling. Birth order sums up several variables, not just one. It is a surrogate for differences in age, size, power, and privilege among siblings.

Not only should birth-order differences exist, but they should fall into predictable behavioral classes. For example, eldest children, who are more reproductively valuable to their parents, should zealously defend their favored status. It is not necessary for a firstborn to be favored consistently in order to behave in this manner. Parents also have an interest in protecting younger siblings against the physical onslaughts of their elders

and in minimizing sibling conflicts. What is crucial is that siblings be attentive to any differential valuation. One well-established finding about siblings is how exquisitely sensitive they are to any apparent favoritism by parents (Dunn & Plomin, 1990, p. 73). No evolutionary psychologist should be surprised by this finding. Sibling rivalry is "Darwinian common sense."

In terms of the Big Five personality dimensions, one would expect firstborns to be higher on Antagonism, which reflects aggressive and retaliatory behavior (McCrae & Costa, 1987). For the same reason, firstborns should score higher on Extraversion, in the specific sense of "assertiveness" or "dominance." Firstborns should also be more amenable to their parents' wishes, values, and standards. Displaying greater respect for parental authority would inevitably make sense for anyone having favored status. For this reason, firstborns should rate higher on Conscientiousness, which includes many behavioral elements that reflect conformity to parental values. Firstborns, in short, should identify more strongly with parents and authority (Kagan, 1971, p. 148). Laterborns, to the extent that they seek to reverse the higher status of older siblings, should be more likely to rebel against parental authority.

A prediction for Neuroticism, the fourth of the Big Five personality dimensions, is less straightforward. Still, Buss stresses the importance of jealousy in maintaining valued resources, and this insight may provide a relevant guide. Jealousy is a behavioral trait that is integrally related to Neuroticism (or Emotional Instability). Following this line of logic, firstborns ought to display more emotional outbursts, more sensitivity to defeat, and other "temperamental" tactics as they seek to safeguard their privileged status.

The only behavioral dimension of the Big Five on which laterborns should score higher is Openness. This outcome stems directly from their lessor identification with parental authority. Openness also entails traits like being "daring," "untraditional," and "rebellious." It is foolhardy for firstborns to take unnecessary risks if their survival and reproductive interests are already favored. It may be paramount for laterborns to do so.

In considering whether these hypothetical differences are reasonable, it is helpful to ask whether individuals holding high status in any social hierarchy would preserve their status in the most effective manner if they were typically shy, submissive, flexible, trusting, even-tempered, playful, and unconventional. I think not. These adjectives, which all derive from the Big Five dimensions, describe exactly the opposite behaviors that I have sketched for a good "Darwinian firstborn." These are the behaviors of laterborns.

A Meta-Analytic Review

Given the considerable impact that Ernst and Angst's (1983) resounding dismissal of the birth-order literature has had on psychologists, I have undertaken a meta-analysis of their own review. In a postscript to the preface of their book, Ernst and Angst regretted that meta-analytic methods had become available only as they were completing their study and hence were not employed by them. Owing to their demonstration of the numerous flaws in the literature, this omission might seem unimportant. But from the Darwinian perspective that Buss and other evolutionary psychologists are now seeking to promote, a proper meta-analysis of this literature becomes imperative. The question is, then, were Ernst and Angst really right?

If we decide to ignore all birth-order studies up through 1980 that were uncontrolled either for social class or sibship size, we are left with 196 well-designed studies. It was largely on the basis of these controlled studies, involving 120,800 subjects, that Ernst and Angst (1983) concluded that birth-order effects did not exist. In order to categorize this literature in more meaningful behavioral terms, I have classified each of the 196 controlled studies under one of the Big Five personality dimensions. That is, I have grouped each study under the most relevant of these dimensions, following similar classifications already employed by Ernst and Angst (Table 1).

Within this reasonably controlled literature, 72 of the 196 studies displayed significant results in the predicted direction. Only 14 studies indicated an opposite result. The remaining 110 studies reported inconclusive outcomes. What does this all mean? Here is where meta-analytic techniques help to make sense of the results. The number of confirming studies (72) is far greater than chance expectation, which would have produced only 9.8 positive results ($p < 1$ in 100 million). Four of the Big Five personality dimensions exhibit clear-cut results in the predicted direction. The largest effect occurs for Openness, indicating that laterborns are more unconventional and rebellious. Only Extraversion yields a conflicting result, in that both positive and negative studies are more significant than chance expectation. One problem with studies belonging to this behavioral category is that researchers tend to confuse "seriousness" in firstborns, which is often a sign of adult values and conscientiousness, with "introversion." It is worth emphasizing that these results are significantly heterogeneous among themselves, $\chi^2(4) = 44.96$, $p < .001$ (for this statistical test, see Rosenthal, 1987, p. 193). Findings on Openness and Conscientiousness are more consistently in the expected direction, by a significant margin, than findings on either

Table 1. *Summary of 196 Controlled Birth-Order Studies, Classified According to the Big Five Personality Dimensions*

Behavioral Domain	Outcome	Expected Number of Studies "Confirming"[a]	Probability of Being a Chance Effect[b]
Extraversion			
Firstborns Are More Extraverted, Assertive, and Likely to Exhibit Leadership Qualities	5 confirming (17%) 6 negating 18 with no difference	1.5	$z = 5.01, p < .000001$[c] (but studies clearly conflict)
Agreeableness/Antagonism			
Laterborns Are More Approachable, Popular, and Easygoing	12 confirming (39%) 1 negating 18 with no difference	1.6	$z = 8.44, p < .0000001$
Neuroticism (or Emotional Instability)			
Firstborns Are Less Well-Adjusted and More Anxious, Neurotic, Fearful, and Likely to Affiliate Under Stress	14 confirming (29%) 5 negating 29 with no difference	2.4	$z = 7.68, p < .0000001$
Openness			
Firstborns Are More Conforming, Traditional, and Closely Identified With Parents	21 confirming (49%) 2 negating 20 with no difference	2.2	$z = 13.19, p < .0000001$
Conscientiousness			
Firstborns Are More Responsible, Achievement Oriented, Organized, and Planful	20 confirming (44%) 0 negating 25 with no difference	2.3	$z = 12.14, p < .0000001$
All Results Pooled	72 confirming (37%) 14 negating 110 with no difference	9.8	$z = 20.39, p < .00000001$

Note: Data are tabulated from Ernst and Angst (1983, pp. 93–189), using only those studies controlled either for social class or for sibship size; each reported finding constitutes a "study."

[a]Based on an expected confirmation rate of 5% by chance. (Even with the expected number of confirming studies set to a minimum of 5, all statistical comparisons reported here are significant at $p < .005$.)

[b]Based on the meta-analytic procedure of counting significant confirming studies versus all others (Rosenthal, 1987, p. 213); one-tailed test.

[c]In this one instance, I compared positive and negative studies together, versus those showing no difference, and employed a two-tailed test.

Agreeableness or Neuroticism, which are in turn significantly more likely to be confirmed than findings involving Extraversion. Thus, birth order is clearly more important for some aspects of personality, like Openness, than for others. Extrapolating from Table 1 and from effect sizes reported in well-controlled studies, it is reasonable to posit a diverse range of effect sizes for birth order. Under the most behaviorally appropriate circumstances, researchers may anticipate the following maximum correlations for birth-order effects as they related to the Big Five dimensions: Openness ($r \approx .40$), Conscientiousness ($r \approx .35$), Agreeableness ($r \approx .30$), Neuroticism (in the limited sense of greater jealousy, $r \approx .20$), and Extraversion ($r \approx .10$). Considering that a correlation as small as .10 is equivalent to improving one's chances of surviving a deadly disease from 45% to 55%, these expected correlations are hardly trivial.

Evolutionary psychology will naturally want to make far more specific predictions than "firstborns tend to be neurotic" or "laterborns tend to be introverted." As far as evolutionary psychology is concerned, there is a limit to the usefulness of my five meta-analytic categories, which are intended only as a rough guide. What is remarkable is that even such a crude scheme of behavioral classification yields such consistent results.

Several other conclusions can be drawn from this meta-analysis. I have included several variables in my data base to test impressionistic claims made by Ernst and Angst (1983). For example, Ernst and Angst repeatedly argued that significant birth-order effects are found among children but that such effects rarely occur in studies of adults. They concluded that birth-order effects, even if they do exist, are developmentally ephemeral. I have controlled all the studies in Table 1 for the age of the subjects. There is almost no correlation between age of subjects and the outcome of the studies ($r = -.04$), refuting Ernst and Angst's claim. Ernst and Angst have also repeatedly criticized the use of self-ratings and paper-and-pencil tests. Here they are right. In my meta-analytic review, only 31% of studies

involving self-ratings were in the predicted direction, whereas a higher proportion of studies (55%) reported significant results with real-life situations or "observer data" ($r = .22$), $\chi^2(1, N = 196) = 9.60$, $p < .0001$. The birth-order literature includes some studies that report null findings with self-report data but that show significant results in real-life situations using the same sample! Thus birth-order differences are especially robust in real-life situations.

As Buss notes in the target article, evolutionary psychology is fundamentally a context-sensitive approach to behavior. In a forthcoming study of radical thinking in science, I show that birth-order effects are remarkably context sensitive (Sulloway, 1994). During scientific revolutions, the effect size for birth order, as it relates to receptivity, is moderated by a dozen other variables that reflect the "controversial" aspects of new theories. There are many ways for ideas to be controversial. In 28 scientific debates that I have studied, birth-order effects range from $r = .45$ (in favor of greater laterborn acceptance) to $r = -.24$ (in favor of greater firstborn acceptance). Still, these diverse effect sizes can be predicted with considerable accuracy based on the dozen known moderator variables. Laterborns consistently support "radical" revolutions like Copernicanism and Darwinism; firstborns support only those scientific innovations that are highly technical or that entail distinctly "conservative" ideological implications. Some revolutions in science inevitably exhibit no birth-order effects because, during these events, moderator variables are evenly balanced. The literature on birth order is unfortunately characterized by a pervasive failure to capture these kinds of ever-present interactions between moderating circumstances and resulting behavior.

The File-Drawer Test

It is well known that researchers seek to publish, and journals tend to accept, studies displaying significant results. This is known as the "file drawer" problem (Rosenthal, 1987). It is possible to determine the number of unpublished studies that would have to be sitting around in file drawers in order to invalidate the significant findings that I summarize in Table 1. Rosenthal (1987) suggested, as a "rough and ready guide" to this problem, that N, the number of studies in file drawers, be set to 5 times the number of published studies plus 10. The extra 10 ensures that N is at least 15 when the number of published studies is just 1, yielding a probability of 5% for the occurrence of significant findings.

Rosenthal's (1987) formula yields a generous estimate of 990 unpublished birth-order studies lying around in file drawers, given the 196 published studies. (This calculation applies only to controlled studies.) According to Rosenthal, the actual number of controlled studies that would be required to invalidate the results in Table 1 can be given by the formula $X = 19S - N$, where S is the number of significant studies and N is the number of nonsignificant studies. This number (1,244) exceeds 990, indicating that the published findings pass the file-drawer test. In short, by the most stringent criteria of meta-analytic excellence, birth-order effects are consistenly present. Poor research design, a lack of attention to behavioral context, and weak theoretical guidance have indeed plagued this literature, as Ernst and Angst have rightly argued. These are precisely the problems that evolutionary psychology should help to resolve.

A Darwinian Aside

In the historical study that I have conducted over the last two decades, I have found laterborns to be significantly more likely than firstborns to adopt radical innovations in science (Sulloway, 1994). Darwin, the fifth of six children, and Alfred Russel Wallace, the seventh of eight, pioneered a radical revolution in which birth-order effects were sizable. Amiable, socially liberal, and open-minded, these two evolutionary theorists were reasonably typical of their laterborn contemporaries. In the course of my research, I have documented the positions of more than 600 scientists who spoke out on evolutionary theory from 1700 to 1875. I have also asked more than 30 historians of science to verify this sample, to rate the participants on their degree of "acceptance" of the theory, and to suggest relevant additions. Individual laterborns were three times as likely as firstborns to support evolutionary theory ($r = .40$), $\chi^2(1, N = 443) = 69.73$, $p < 1$ in 100 million. When Darwin himself converted to evolution in 1837, the disparity by birth order was 10 to 1 in favor of laterborns (Figure 1). These data are controlled for sibship size, social class, social attitudes, and many other relevant considerations. The observed birth-order effect is not an artifact of these background factors.

Although Darwin was unaware of this laterborn bias for challenging the status quo, he was fully cognizant of the pernicious effects of firstborn favoritism. To Alfred Russel Wallace, who could not have agreed more, Darwin wrote in 1864: "But oh, what a scheme is primogeniture for destroying natural selection!" (Darwin, 1887, vol. 3, p. 91). In the century since Darwin made this observation, evolutionary psychology has emerged as a thriving discipline. Now that it has, sibling differences should finally begin to receive proper recognition as natural consequences of the Darwinian dramas that we all enact.

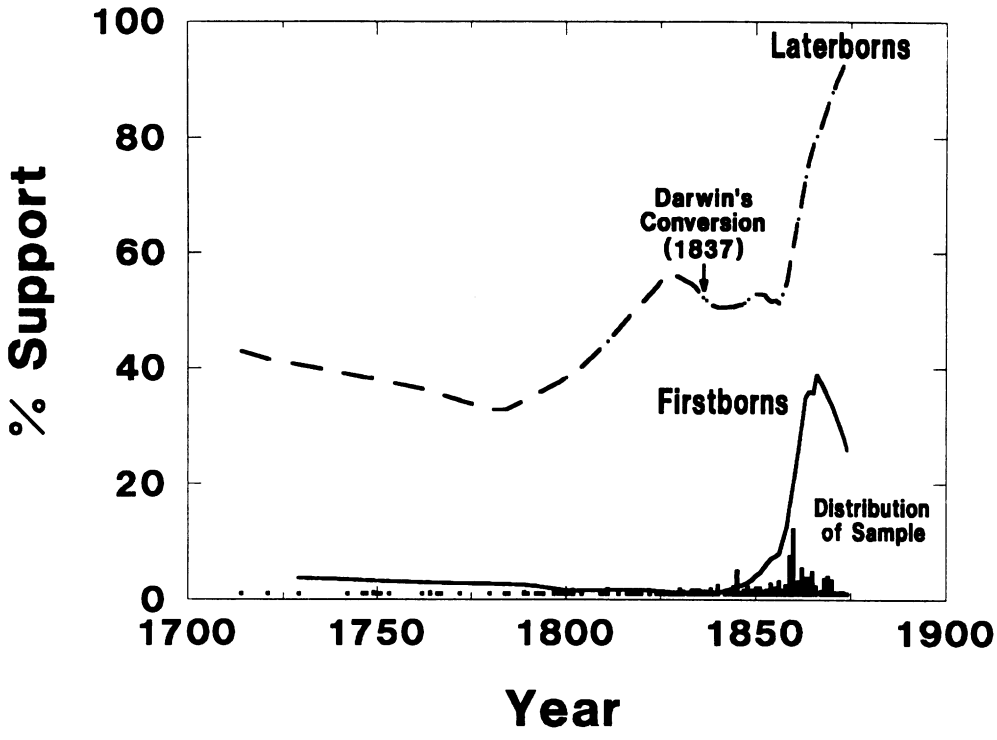

Figure 1. *The reception of evolutionary theory by birth order from 1700 to 1875 (N = 443). During the century preceding publication of Darwin's* Origin of Species *(1859), individual laterborns were four times more likely than firstborns to support evolution. In some decades, these group differences were as great as 10 to 1. For the entire period considered here, being laterborn increased support for evolution from 21% to 61%. The temporary downturn in laterborn support for theories of evolution in the 1830s and early 1840s reflects the domineering influence of firstborns Georges Cuvier and Charles Lyell, who strongly opposed this theory.*

Notes

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