Comment

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Methodology, Birth Order, Intelligence, and Personality

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Conclusions about the effects of birth order on intelligence, personality, and other psychological and behavioral domains depend on the research designs used to study those effects. There are two key research designs, between-family designs and within-family designs. Rodgers, Cleveland, van den Oord, and Rowe (June 2000) used both designs to assess the relationship of birth order to intelligence. The results of the within-family design revealed that birth order is unrelated to intelligence. The results of the between-family design, in contrast, revealed a negative relationship between birth order and intelligence. Rodgers et al. concluded that the belief that birth order affects intelligence is a product of research using between-family designs and the presumption that large families produce low-IQ children. According to Rodgers et al., within-family tests of the relationship between birth order and any behavioral outcome decrease variation from variables extraneous to the family and, therefore, are preferable to between-family tests of these relationships. Rodgers et al. claimed that their "primary methodological point applies equally to any psychological or behavioral domain" (p. 600).

According to Rodgers et al. (2000), appropriate tests of the relationships between birth order and personality require a within-family design. In contrast to the null results of within-family tests of the relationship between birth order and intelligence, within-family tests document significant relationships between birth order and personality (Paulhus, Trapnell, & Chen, 1999). Using a within-family design, Paulhus et al. (1999) found that first-borns are reported to be higher achievers and more conscientious, whereas later-borns are reported to be more rebellious, agreeable, and liberal. These findings are not obtained when the same relationships are assessed using a between-family design (Freese, Powell, & Steelman, 1999; Michalski & Shackelford, 2000).

These different patterns of relationships between birth order and (a) intelligence and (b) personality require explanation. There are several differences in the logic predicting birth order relationships with intelligence and personality. For example, Sulloway's (1996) claims regarding personality were constructed around the influence that an older, dominant sibling can exert over a younger, submissive sibling. Predictions regarding birth order differences in intelligence do not necessarily reflect this sibling competitiveness. Instead, these predictions rest largely on parental willingness and ability to invest in a child, which tends to decrease as the number of siblings increases (Blake, 1987). To the best of our knowledge, no research has systematically addressed how sibling interactions affect intelligence.

Within-family designs provide several methodological advantages over between-family designs. For example, variations in social class, number of siblings, and parental personality are reduced in a within-family design because data for each sibling are collected. Each sibling is presumed to grow up with the same economic background, family size, parental IQs, and parental personalities. Is it correct to assume that the reduction in variation of these effects makes these within-family designs more appropriate than between-family designs? The answer may be *no*. A within-family model does not account for

within-family change over time. Additional confounds can be included in both within-family designs and between-family designs. For example, a man's social status and expendable resources often increase with age (Buss, 1994). Later-born children therefore may be born into an economic situation different from that of an older sibling. This raises several issues relevant to intelligence. A father with more resources at Time 2 than at Time 1 may be more likely to distribute those resources at the time in development when they may be more important to the intellectual development of younger offspring. Although parents with low IQ or low socioeconomic status (SES) produce more offspring than high-IQ parents or high-SES parents, there is little reason for a within-family design to fail to address this potential source of variation. Perhaps the null effects presented in Rodgers et al.'s (2000) article were due to an increased ability of parents to invest in later-born offspring.

Another point regarding reduced variation in a within-family design is the assumption that children within a family share the same family size at any given time. The addition of a newborn into a family, however, may elicit different reactions from older children and younger children who are already part of the family. From an evolutionary psychological perspective, the costs incurred with parental production of additional offspring may be greater for younger siblings than for older siblings because of the diversion of parental resources toward a newborn that might otherwise have been invested in the next oldest child (Sulloway, 1996). Therefore, what siblings mean to each other as allies and as adversaries may differ with birth order. The potential for growth in family size thus may be interpreted in different ways as a function of birth order.

Intelligence can be defined as the mental abilities necessary to effectively adjust to one's environment as well as to effectively shape and select one's environments (Sternberg, 1997). Intelligent individuals have the ability to maximize

success either by adjusting their behaviors to the local environment or by manipulating their environment to facilitate their strengths. This definition of intelligence parallels the logic that Sulloway (1996) proposed regarding later-born disadvantage and the personality characteristics that later-borns adopt to increase parental investment. It is possible that, given the methodological issue at hand, it may not be intelligence per se that covaries with birth order but the ways in which intelligence is used. Intelligence may be used by siblings to develop personalities that best utilize their niche. Perhaps this is why within-family designs yield differences in personality but not intelligence as a function of birth order. Within-family designs may identify only the absence of a relationship between birth order and intelligence. Further research could profitably address (a) the ways in which intelligence is used in personality and (b) confounds not previously included in either between-family or within-family studies of birth order.

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On Family Size and Intelligence

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Because of methodological flaws and incomplete data, Rodgers, Cleveland, van den Oord, and Rowe's (June 2000) article is not the last word on family size and IQ. It not only failed to settle the effect of birth order on IQ, it overstated the importance of mothers' IQs at the expense of family size and other family influences. More specifically, their analysis omitted nearly half of the tested children in the sample they studied; they neglected a cognitive ability test (the Peabody Picture Vocabulary Test [PPVT]) that showed significant birth order effects on a much larger sample; and most puzzling, they failed to conduct multivariate analyses, which led to the unwarranted conclusion that "large families do not make low-IQ children in modern U.S. society" (p. 599) and implied that mothers' IQs are the main cause of both large families and low-IQ children. These conclusions led to a misleading headline in *USA Today*: "Mom's IQ, Not Family Size, Key to Kids' Smarts" (2000).

Rodgers et al.'s (2000) article stressed that most existing studies use cross-sectional data, which hamper rigorous inferences about the family effects of birth order on IQ. Their solution was to use the National Longitudinal Survey of Youth (NLSY) data, which has a number of advantages. However, a longitudinal study does not guarantee rigorous causal inferences from a simple bivariate table. Unlike a randomized experiment, longitudinal studies are still subject to selection effects and to the causal ambiguity of bivariate relationships, which can mask the effects of uncontrolled variables. The only way to untangle these complex relationships is to do a multivariate analysis, and Rodgers et al. did not do this.

First, Rodgers et al.'s (2000) primary NLSY analysis was based on 1,311 families and 2,566 children who had complete achievement test data for all siblings as of 1990 or 1992 (see Rodgers et al., 2000, Table 1 and Figure 4). That is, the analysis was based on those families that had test scores for all of their children in those two years (called *intact families*). Excluded were families with children who were too young or too old for the achievement tests in those two years (ages 5 to 15), children who were tested in 1986, 1988, or 1994

but not in 1990 or 1992, and children who were in the proper age range but who were not tested for other reasons. In any assessment year, the math test was not administered to about 10% of the children, and an even higher percentage were not given the reading test (especially among those ages 5 to 7 years). Rodgers et al. replicated their results on a second sample of families using 1994 and 1996 data, but it is likely that many of these families were also included in the first sample, so it is not actually an independent replication sample. Breaking up the sample of children in this way eliminated families that might have had complete data if all available test scores between 1986 and 1996 had been utilized.

These losses of data could have biased the intact family subsample by excluding (a) mothers who had children very early and whose older children were beyond the testing age in 1990 or 1992, (b) mothers who delayed having children and whose younger children were below the testing age, and (c) families who had one or more children who did not take the achievement tests. The rate of omitted families became higher as families became larger because there was a higher probability that at least one child did not have test scores. Thus, Rodgers et al. (2000) analyzed only 233 three-child families, 56 four-child families, and 14 five-child families, when in fact there were over 800 three-child, 280 four-child, and 70 five-child families with achievement scores for some of their children. Altogether, as of the 1994 assessment, the NLSY had over 3,200 families and 6,100 children with math scores in at least one assessment and had about 3,000 families and 5,200 children with at least one reading score.

Second, it is unclear why Rodgers et al. (2000) did not examine the PPVT in their analysis. This test is especially important in preserving NLSY cases because it was administered to all children ages 3 years and over, thereby generating the largest number of intact families for a within-family analysis. The PPVT is probably more fittingly described as an IQ test than either the math or the reading achievement tests.

With the PPVT, the relationship between verbal ability, number of children, and birth order can be examined for 2,447 intact families with test scores for all of their children between 1986 and 1994 (similar to the analysis shown in Table 1 in Rodgers et al.'s [2000] article). This simple bivariate analysis yields a strong birth order effect of 3 points for firstborn versus second-born children and about 2 points for second-born versus third-born children.