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ABSTRACT

This study explores and evaluates the explanations for apparent exception to the family size rule that IQ and family size are inversely related. Three large-scale studies were consistent in placing only children lower than firstborns from two-, three-, and four-child families, and at about the same level as firstborns from a five-child family. The explanations considered are conceptualized within the confluence model (Zajonc, 1975) which proposes that intelligence develops as a function of a combination of factors, including the child's age and experience within the family, and additionally suggests that sibling tutoring is beneficial to the intellectual development of the tutor. The author criticizes several aspects of the confluence model and states that the lack of research in this area is a further obstacle to valid conclusions. She feels that sibling tutoring is nothing more than a convenient explanation motivated by the desire to improve the correlation between simulated and real data, with little external support. She argues that further research should be conducted to test the explanation. (PFS)

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Sibling Tutoring and Other Explanations for Intelligence:

Discontinuities of Only and Last Borns

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Running head: Sibling Tutoring and Other Explanations for Intelligence

Sibling Tutoring and Other Explanations for Intelligence Discontinuities of Only and Last Borns

Introduction. Sufficient quantities of respected research results exist to support the statement that IQ and family size are inversely related.[1] On the basis of this negative relationship, one would expect only children to have the highest IQ of all because they come from the smallest family size. Unfortunately, the results of three large scale studies conducted in Holland (Belmont & Marolla, 1973) and in the U.S. (Breland, 1974; Claudy, Notel) are consistent in placing only children lower than this prediction. In these studies only children are found to score lower than first borns from two, three, and four child families and about at the same level as first borns from a five child family. The purpose of this study is to explore, evaluate and extend the explanations for this apparent exception to the family size rule.

The Confluence Model. The explanations considered are conceptualized within the confluence model (Zajonc, 1976; Zajonc & Markus, 1975). This respected ("Zajonc Defuses IQ Debate," 1976) and popular (Zajonc, 1975) model was recently proposed to explain the inverse relationship between intelligence and family size. Basically, this model proposes that intelligence develops as a function of a combination of factors, including the child's age and experience within the family. As children grow older, they become capable of more and more sophisticated intellectual activities. This is partially due to the child's maturation and to the child's interaction with his or her environment. The confluence model proposes that the child's environment is largely defined by the family and it is through the child's experiences within the family that family size has its effects on intelligence.

The confluence model posits that some of the variations in children's intellectual development (beyond variations caused by maturation) are due to the level of intelligence present within their family. Basically, the notion is that the intellectual level attained by children is determined by the overall intellectual level present in the family as the child grows up. The confluence model operationally defines the level of intellectual functioning of a family as consisting of the average of the absolute intelligence of all family members. Absolute intelligence represents the upper level of intellectual operations an individual can perform when tested. Absolute intelligence is uncorrected for age and since children have lower absolute intelligence levels than adults, this means that the intellectual environment of a family is greater the more adult and fewer child members it has.

All tests of the model have assumed that each family consists of two adults with average adult intelligence and a specified number of children with varying ages and age gaps between siblings. In simplified form, the following represents the intellectual level of a family, before the first child:

$$\frac{100 + 100}{2} = 100.$$

After the birth of the first child, the intellectual level of the family changes drastically. As a newborn, the first child's intelligence would be close to zero. Applying the simplified version of the confluence model, we can see that

$$\frac{100 + 100 + 0}{3} \cong 66.6$$

the arrival of the first child depresses the overall intellectual environment of the family. As children grow older, their absolute intelligence increases. Let's give the child the age of 5 years and an absolute intelligence of 50. Applying the simplified confluence model, one can see that

$$\frac{100 + 100 + 50}{3} = 83.3$$

the overall intellectual level of the family has improved. Now, let's say that the parents have another child. The arrival of the newborn means that the intellectual level of the family is

$$\frac{100 + 100 + 50 + 0}{4} = 62.6$$

or only slightly less than after the arrival of the first child. Thus, one would predict that if this second child were the last, that he or she would attain an intellectual level similar to that of the first born because the child would mature in an intellectual environment comparable to that experienced by the first born. Empirical evidence about age gaps support the prediction that with age gaps of four or more years, later borns are likely to meet or surpass the intelligence level of earlier borns (Zajonc, 1976).

If the two child family did not have this age spacing between the children, then the average intellectual environment would be less than the hypothetical 62.6. Let's say that there was no spacing between the siblings--that is, that the couple had twins. If the couple had twins, the intellectual level of the family at the twin's birth would be:

$$\frac{100 + 100 + 0 + 0}{4} = 25.$$

In this fashion, the confluence model explains the repeated finding that twins have an average of five IQ points less than single births from comparable family sizes (Record, McKeown, & Edwards, 1970). In general, the arrival of several low mental ages in a relatively short time span precipitously lowers the overall intellectual environment of the family. According to the confluence model, this depressed intellectual environment has a detrimental effect on intellectual development.

In addition to representing the combined effects of family size, birth order, spacing, and maturation on the development of intelligence, the confluence model includes yet another factor: sibling tutoring. This factor was derived from an examination of the Belmont and Marolla (1973) IQ data which indicated two discontinuities from the generally inverse relationship between family size and intelligence. These discontinuities were associated with only and last borns. Specifically, the discontinuity associated with only children was the result of a comparison between only children and first borns from families of different sizes. According to Zajonc and Markus (1975), only children scored 1.039 less than would be expected from an extrapolation of the scores of first borns. The discontinuity of last borns was based on a different comparison. The average drop in intelligence between the next-to-the-last and last born was greater than the average drop between earlier born age-adjacent siblings. As reported in Zajonc and Markus (1975), the average drop for the last born was .68; while the drop for adjacent pairs of earlier born siblings was .23. Because Zajonc and Markus (1975) considered the size of the discontinuity for only and last born to be similar in magnitude and because only and last borns shared the common fate of not having a younger sibling, Zajonc and Markus suggested that the cause of the discrepancy must be their common lack of a younger sibling. They argued that having a younger sibling gives the older child the opportunity to tutor, and tutoring a younger sibling was proposed as beneficial to intellectual development. The value assigned to the sibling tutoring factor was zero or one. Zeros were added to equations representing only and last borns and ones were added to the equations representing all other birth order/family size cases, regardless of the number of younger siblings available to tutor.

Tests of the confluence model consist of comparisons of the similarity between actual intelligence data and simulated data, generated from equations representing the confluence model. With the addition of the sibling tutoring factor, the regression equation expressing the confluence model accounted for 97% of the variance in the Belmont and Marolla Dutch data.

Unfortunately, the main basis of support for the existence of the sibling tutoring effect is this extremely high correlation between the empirical and simulated data. That is, the sibling tutoring explanation was proposed and accepted even though there is no evidence that tutoring a younger person results in a permanent (or even temporary) intelligence gain for the tutor. While there is ample evidence that even kindergarten-aged children can tutor younger children, tests of the effects of this tutoring have been limited to studies of the acquisition of social skills and academic content (Allen, 1977). Furthermore, even though the presence of a younger sibling enhances the opportunities for tutoring, there is no evidence about how much tutoring of younger siblings actually goes on within a family.

Zajonc (1976) attempted to make the sibling tutoring factor seem plausible by citing research indicating that an active approach to learning is superior to a passive approach. Teaching someone younger is presumably a more active approach to the acquisition of knowledge than being taught by someone older. However, the evidence (Burnstein, 1962; Craik & Lockhart, 1972; Zajonc, 1960) which demonstrates the superiority of the active approach to learning is limited to research on levels of information processing and the activation of various cognitive structures and does not concern changes in intelligence.

Thus, the support for the sibling tutoring effect is entirely circumstantial. More damaging that this, however, is the fact that only and last borns do not always demonstrate an IQ deficit. Zajonc (1976) presented aggregate Scottish and French data which indicated that only last borns have an intelligence advantage. Among 11 year old Scottish children, only children have the highest IQ of all and last borns have higher IQs than next-to-last borns. Similarly, in France, only children (6-14 years old) have the highest IQs except for the second of a two child family. Here, too, last borns generally do better than the next-to-last child in the family. Thus, not all large scale studies of intelligence, family size, and birth order are consistent in finding only and last borns as lacking in IQ. The Scottish and French data places only children where one would predict from their birth order and family size. Furthermore, both French and Scottish results indicate that last borns actually do better than next-to-the-last borns.

Cognitive Development. Taking together the Dutch, American, French, and Scottish results one might conclude that only and especially last borns have an IQ advantage up until adolescence which shifts into a disadvantage during late adolescence. The shift must occur between the ages of 15 (oldest documented age at which only and last borns have an advantage) and 17 (youngest documented age at which only and last borns have a disadvantage). According to Markus and Zajonc (Note 2), such a shift is compatible with the confluence model. They simulated data representing the intelligence of 11 year olds and included in the equation the sibling tutoring factor. Comparing the simulated data with the Scottish data on 11 years olds, they found a remarkable similarity. The correlation between the simulated and actual intelligence data is .80. The data for 11 year olds based on the confluence model was similar to actual data in that in both cases, only and last borns have a slight advantage. Markus and Zajonc explain the shift from advantage to disadvantage in terms of the sibling tutoring effects not accumulating until later ages.

Alternately, one might enhance the plausibility of the intelligence shift by citing parallels in changes brought about by passing from one stage of cognitive development to another. It is possible that rather than the shift being due to a gradual accumulation, it could be due to the child changing from one stage of cognitive development to another. For example, Piaget's theory of cognitive development (Piaget, 1952; 1957) basically describes children as passing through a series of stages in which they can perform qualitatively different intellectual activities. The onset of adolescence is associated with a major change in cognitive development: the stage of formal operations. Before this stage, children are capable of some forms of abstract thought such as producing a mental image of a series of events and conserving quantity. In the formal operations stage, children begin to mentally generate many possible solutions to problems and to think hypothetically. They begin to be aware of themselves as others see them. It is possible that having a younger sibling to tutor enhances intelligence only during adolescence because only at this stage do children have the cognitive apparatus to benefit fully from taking the teacher role.

Furthermore, it seems possible that stage of cognitive development interacts with the opportunity to tutor a younger sibling to produce the shift from IQ advantage to disadvantage for only and last borns. That is, it is possible that the absence of a younger sibling during middle childhood is a help to intellectual development; while, the same absence during adolescence results in a hindrance to intellectual development. An elaboration of this interaction follows.

One consequence of being an only or last born is that all other family members are older. Therefore, everyone in the family is behaving at more advanced level than the only or last born. When a child is in the stage of concrete operations, such a family environment could be beneficial to intellectual development in that the child has only more mature models to observe and imitate. In constrast, early borns are exposed to both adult and younger child models of behavior and this means that the early born is exposed to models of both more and less mature behavior. In the case of only children it is likely that the home environment is much more mature since the child is exposed only to adult behavior. Given this exposure, one would predict that only children would behave in more adult-like ways than other children. Some evidence exists to support this prediction (Eiduson, Note 3; Guilford & Worcester, 1930; LeShan, 1960). No comparable evidence exists for last borns which may reflect the fact that no one has collected the data yet or that last borns do not behave as maturely as only children. It seems likely that investigations of last borns will support the prediction that last born children do not behave as maturely as only children because last borns have at least some child models (even if older) in their home environment. Furthermore, there is evidence that home environments shift drastically from being adult oriented (which is found when there is zero or one child) to being child-oriented with the arrival of the second child (Eiduson, Note 4). Thus, compared to only children, last borns would inevitably arrive into a child-oriented home, and this would decrease the likelihood that they would demonstrate precocity at adopting adult-like behavior.

At adolescence, the child moves into the stage of formal operations. The adolescent can try out different ways of teaching, see the learning experience from the eyes of the learner, and explore these differing perspectives. Sibling tutoring would give adolescents the opportunity to exercise their newly acquired cognitive abilities, thereby possibly enhancing intelligence. One flaw in this elaboration of the sibling tutoring explanation is that the onset of formal operations generally occurs around the age of 12. As mentioned previously, there is aggregate data which indicates that the shift from advantage to disadvantage doesn't occur until 15. Thus, anyone using stage changes as support for the plausibility of the sibling tutoring explanation would have to explain why it takes at least three years for the intelligence shift to occur. The only obvious reconciliation here is that the shift represents an accumulation of experience within a maturationally induced stage change in cognitive development.

Alternatives. In proposing the lack of sibling tutoring as an explanation for the intelligence discontinuities of only and last borns, Zajonc and Markus (1975) were apparently motivated by parsimony, a well respected canon of science. However, it is possible that some of the factors responsible for the intelligence discontinuity of only children are different from those responsible for the discontinuities of last borns. The alternative explanations considered in this paper focus on the differences between only children and last borns.

Basically, these alternative explanations can be conceptualized within the parameters of the confluence model. Because the alternative explanation for only children has not been presented elsehwere, it will be presented first.

In predicting the intelligence of various family configurations, Zajonc and Markus (1975) assumed that the frequency of parental absence (usually father absence) was evenly distributed across family sizes. If the incidence of parental absence, or single parenting is more among certain family size groups, the confluence model would predict that the children from these family sizes would have lower intelligence. Certainly there is ample evidence that children from father absent homes have lower IQs than children from father present homes (Biller, 1974; Blanchard & Biller, 1971; Broman, Nichols & Kenneth, 1975; Carlsmith, 1964; Lynn, 1974; Marino & McCowan, 1976; Sutton-Smith, Rosenberg & Landy, 1968).

The incidence of father absence has potential relevance to the case of only children because it seems plausible that one reason why parents have only one child is that the father is absent. On the basis of what is known about ideal family size and the reasons why women have an only child, it seems likely that father absence is more common among one child families than multi-child families. Surveys aimed at assessing the upper and lower limits of socially acceptable family sizes have found that approximately 78% of Americans sampled in both 1950 and 1972 said they thought being an only child is a disadvantage (Blake, 1074). Combined with an analysis of other survey information, this clearly negative appraisal of only children led Blake (1974) to conclude that the two child family is and has been the lower limit of socially acceptable family size. In view of this it would appear that most people who have a one child family do so not because it approximates their notion of an ideal family size. Instead, it seems likely that people have an only child because they are subfecund or their spouse is absent. Indeed, there is evidence of greater subfecundity among only child mothers than mothers of more children (Beckman, Note 5; Falbo, Note 6). What evidence is there about the incidence of father absence in one child families? The answer to this question can be found in Census (U.S. Bureau of the Census, 1970) information regarding the marital histories of women who have completed their family size. Table 1 presents the marital

Table 1 about here

status information of ever-married, white women, broken down by family size. Similar tables could be generated for Black women. The data is presented in terms of the frequencies and percentages of women of each family size who fit into the marital status, husband present categories. Because completed family size is of interest, only women who are past the childbearing age (45-49) are considered.

Table 1 presents the data for all white women. This table indicates that one child families are slightly less likely (4-5%) to have a father present in the family than multi-child families. Furthermore, it appears that the incidence of divorce is more common among one child families than multi-child families.

The discrepancy between the one child families and other families becomes more extreme when one considers only urbanized whites. One can see from Table 2 that father presence is lowest among the only

Table 2 about here

child group. Here, too, divorce is much more common than among multi-child families.

This means that in America only children are more likely to be the product of a single parent home. Whether the magnitude of the difference in the incidence of father absence is sufficient to account for the intelligence discontinuity of only children remains to be studied.

Zajonc (1976) suggested an additional explanation for the intelligence discontinuity of last borns. Specifically, Zajonc proposed that the age spacing between the last and next-to-last child could account for discrepancy between the predicted and actual intelligence scores of last borns. In fact, Zajonc (1976) reports that long gaps between the ages of the last and next-to-the-last child are associated with a disappearance of the intelligence drop of last borns. Unfortunately, there is no aggregate intelligence data which includes the age spacing between siblings. Therefore, a test of this alternative explanation is not currently possible.

Summary and Conclusions. The sibling tutoring explanation for the intelligence discontinuities of only and last borns has little support. This lack of support is partially due to the nonexistence of relevant research directly testing the effect of tutoring a younger child on the intelligence of the tutor. However, there are other sources of doubt about the sibling tutoring explanation. The first concerns the finding that only and last borns have been shown to possess an intelligence advantage up until the age of 15. This means that a major shift in intelligence occurs between the ages of 15 and 17, a shift which has not been reported in the developmental literature. The stage of formal operations beings around the age of 12 and if this stage is involved one would expect the shift from advantage to disadvantage to occur at 12 or 13, not after 14.

A second source of doubt about the sibling tutoring factor concerns the evidence presented by Zajonc & Markus (1975) in support of it. Note that the chief support comes from the strong correlations between the data generated from the confluence model and empirically derived data. Although this correlation before the inclusion of the sibling tutoring factor has not been reported, one can assume that the inclusion of this factor improved it. It would be useful in evaluating the sibling tutoring factor to have the magnitude of this improvement stated. For example, if the inclusion of sibling tutoring greatly enhances the correlation between the simulated and real data, this would mean that the predictive strength of the confluence model without the sibling tutoring factor is relatively weak. If the magnitude of this improvement is small, then the impact of the sibling tutoring factor on intelligence is low.

Skepticism should also be aroused by the value assigned to the sibling tutoring factor. Essentially, the inclusion of this factor in the equations representing the confluence model means that the number one is added to all cases except only and last borns, who have zero added to the equations representing their intellectual environments. Obviously, such a procedure alters the simulated data so that it predicts the lowered intelligence of only and last borns. Furthermore, the value of one was given to all birth order/family size cases, regardless of the number of younger siblings present in the family to tutor. If tutoring a younger sibling has a cumulative effect on the development of intelligence, why whouldn't having more than one younger sibling be represented in the equation?

In view of these criticisms, the sibling tutoring explanation appears to be nothing more than a convenient explanation motivated by the desire to improve the correlation between the simulated and real data and with little external support. Further research should be conducted to substantiate the effects of sibling tutoring on intelligence and to test the alternate explanations suggested in this paper.

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Table 1

Marital Status and Husband Presence for White Women, 45-49 Years Old, Ever Married, by Number of Children: 1970[1]

Marital Status/ Husband Presence	Number of Children 1	2	3	4
Husband Present	606966 (.82)	1245293 (.86)	973346 (.87)	590502 (.87)
Husband Absent	27343 (.04)	40795 (.03)	33909 (.03)	21538 (.03)
a) Separated	15973 (.02)	22205 (.02)	18677 (.02)	11717 (.02)
b) Other	11370 (.02)	18590 (.01)	15232 (.01)	9821 (.01)
Widowed	47997 (.06)	73872 (.05)	54714 (.05)	34402 (.05)
Divorced	60211 (.08)	73331 (.05)	50796 (.05)	29200 (.04)
Total Ever Married	742517	1433291	1112765	675642

[1]Based on Table 22 of Women by Number of Children Ever Born (U.S. Bureau of Population: 1970; Subject Reports: Final Report PC(2)-3A.

Note: Percentages appear in parentheses and represent the percentage of women in each family size group who fit into each marital status/husband presence category.

Table 2

Marital Status and Husband Presence for Urbanized, White Women 45-49 Years Old, Ever Married, by Number of Children: 1970[1]

Marital Status/ Husband Presence	Number of Children 1	2	3	4
Husband Present	368259 (.79)	767786 (.86)	573266 (.87)	325375 (.87)
Husband Absent	17716 (.04)	25668 (.03)	20971 (.03)	12611 (.03)
a) Separated	11692 (.03)	15883 (.02)	13208 (.02)	7829 (.02)
b) Other	6024 (.01)	9785 (.01)	7763 (.01)	4782 (.01)
Widowed	30742 (.07)	46399 (.05)	32421 (.05)	18899 (.05)
Divorced	44133 (.10)	52343 (.06)	35958 (.05)	19444 (.05)
Total Ever Married	460850	892196	662616	376329

[1] Based on Table 22 of Women by Number of Children Ever Born (U.S. Bureau of the Census, Census of Population: 1970; Subject Reports; Final Report PC(2)-3A.

Note: Percentages appear in parentheses and represent the percentage of women in each family size group fit into each marital status/husband presence category.