The Formulation of the Confluence Model: Applications in Correlating

Birth Order and Intellectual Development

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Abstract

Zajonc and Markus (1975) created the confluence model in an attempt to quantify the correlation between birth order and intellectual development. Despite the model’s ability to predict intellectual levels using aggregate data (namely Belmont and Marolla’s [1973] data), it fails to account for individual differences within families and personal characteristics that might affect intellectual development. Additionally, the complexity of the confluence model has driven researchers to look for other methods that are both less expensive, and consist of a smaller number of variables. Rodgers (1984) discusses the shortcomings of the model, and demonstrates that a simple linear model is as effective in predicting intellectual levels of individuals based on birth order as the confluence model. Therefore, it is evident that the confluence model does not account for the number of parameters that are necessary in correlating birth order and intellectual development, and a new model would be the most effective method whereby we can understand the causal link that is the focus of the confluence model.

Introduction

The research question being addressed is: “Does the Confluence Model accurately correlate birth order and intellectual development.” To answer this question it is necessary to focus on the creation of the model (Zajonc and Markus, 1975), and its mathematical and psychological elements. Before I embarked on the task of becoming proficient in the mathematics involved in the comprehension of the model, it seemed impossible to accurately define the effects that birth order would have on intellectual development. It does not seem likely that a single model could account for all of the differences between families. In addition, each individual has a different set of environmental experiences, which ultimately affects the individual’s motivation for progress as an intellectual being.
I chose this topic because of the seemingly inconceivable ability to account for all of the differences between people and their environments. I found it ludicrous that a mathematical model could encompass all of the necessary parameters involved in correlating such a complex association between two variables. It would be an immense achievement in the field of developmental psychology if we could understand the correlation between birth order and intellectual development, but human beings are too variable to entirely define the causal link that is the topic of this essay.

Using the framework that Kennison formulated, I was able to identify what the answer to my research question was before I investigated the articles of interest to this topic. My way of knowing is “Tenacity:” I was exceedingly superstitious of Zajonc and Markus’ claims because it seems impossible to mathematically define a human being. To define all of the parameters necessary in understanding every aspect of human intellectual growth it would take a supercomputer that could define every characteristic of every individual, and how that individual’s characteristics are comparable to every other individual’s characteristics. However, causal links are discovered in science on a daily basis, but these links are normally much less vague than the topic I chose. I commend Zajonc and Markus on the mathematical model they created, but they were only able to apply their findings to one study that used aggregate data. Today, researchers are able to make correlations between just about anything, as long as they understand how to manipulate the data to support their conclusion, therefore it is necessary that a scientist always be superstitious of seemingly reasonable research.
The Creation of the Confluence Model

In 1972, Schooler published “Birth Order Effects: Not Here, Not Now,” which concluded that “The general lack of consistent findings revealed by this review leaves real doubt as to whether the chance of positive results is worth the heavy investment needed to carry out any more definitive studies.” Instead of suppressing research centered on finding correlations between birth order and intellectual development, it motivated researchers like Zajonc and Markus to examine existing birth order data, and devise a mathematical explanation for the results of the data. In 1973, Belmont and Marolla conducted a study in the Netherlands consisting of every male who attained 19 years of age between the years of 1963-1966. The research consisted of at least 386,114 data points, and Belmont and Marolla discovered a strong relationship between birth order and intellectual performance. The subjects in the experiment were measured on intellectual performance based on Raven Progressive Matrices.

After the analysis of the data, Belmont and Marolla indentified five distinct features. First, as family size increases, the intellectual performance decreases. Second, intellectual performance declines with birth order within each family. Third, the last child exhibits the greatest decline in intellectual performance. Fourth, if the last-born is not taken into account, birth order and intelligence are “related by a quadratic function.” A quadratic function is a function consisting of data points that when graphed; appear in the shape of a parabola. Based on the data, Belmont and Marolla concluded that intellectual performance declined with increasing birth order, but a growth was found in intellectual performance within families of eight or nine children. Fifth, only the first-born of a four-child family, and the first-born of a single child family had equivalent scores.
In their 1975 study entitled “Birth Order and Intellectual Development,” Zajonc and Markus attempted to explain Belmont and Marolla’s data using a mathematical model (the confluence model). The confluence model, as designed by Zajonc and Markus emphasizes the intellectual environment of the individual, and how it influences intellectual development at various ages. In addition, the authors also described the importance of gaps between children, and how the size of the gaps can affect intellectual performance. The absolute intellectual level of a child is illustrated by Zajonc and Markus (1975) with the following function:

\[ M_t = 1 - e^{-kt} \]

In this equation, \( M_t \) represents the absolute intellectual level of a child, “e” is a constant that is similar in nature to \( \pi \), meaning that it is a constant that has an infinite number of digits, “k” is an arbitrary constant that may indicate individual differences between subjects, and this constant can vary with the type of ability being studied (ie. verbal, perceptual, and mathematical abilities). The value of primary importance in this equation is “t,” which indicates the age in years of the child (making it the variable of study). This function does not remain static however. Zajonc and Markus (1975) describe the function as changing with “new additions and departures from the family, an effect that is summarized by a parameter \( \alpha \)” (p. 77). Therefore, Zajonc and Markus predicted that an only-child who grows into adulthood would have the following function:

\[ f(t) = \alpha_0(1 - e^{-\alpha t}) \]

\( F(t) \) describes the growth of the child after age “t,” which allows the model to predict the intellectual level of the child at any age. The alpha level of zero indicates that a significant change in the intellectual environment of the child has not occurred because the child has no other siblings. However, this function is only applicable until the birth of another sibling occurs,
where \( f(t) \) will change to another function for the first-born, which Zajonc and Markus give the label of \( g(t) \) for one added sibling, and \( h(t) \) for two additional siblings, but the rest of the equation does not change, except for the alpha level which changes based on additions and departures from the family (ex: \( \alpha_1 \) indicates that the first-born has one sibling, and \( \alpha_2 \) the presence of two other siblings).

Zajonc and Markus (1975) then attempt to predict the individual’s absolute intellectual level at maturity, which requires another function because \( g(t) \) can only describe growth past one year of age. Zajonc and Markus (1975) give the following equation to quantify the absolute intellectual level of the individual at maturity.

\[
M_{\text{MRA}} = m_0 + m_1 = f(t) \bigg|_0^{t_{\text{M}}} + g(t) \bigg|_0^{t_{\text{M}}} \\
= \alpha_0 (1 - e^{-k t_{\text{M}}}) + \left[ \alpha_1 (1 - e^{-k t_{\text{M}}}) - \alpha_1 (1 - e^{-k t_{\text{M}}}) \right].
\]

\( M_{\text{MRA}} \) indicates the individual’s absolute intellect at maturity (\( t_{\text{M}} \) describes the individual at maturity), \( M_0 \) is defined as the absolute intellectual level of the individual at birth, and \( M_1 \) reflects the absolute intellectual level of the individual at one year of age. Based on the parameters of this equation, \( M_1 \) will have less of an effect than \( M_0 \) as the individual increases in age. In addition, “\( t \)” represents the mean age gap between the siblings, and “\( t_{\text{M}} \)” represents the age of the individual taking the exam measuring intellectual ability. Zajonc and Markus (1975) maintain that the growth parameter of alpha is of primary importance in this analysis because it “reflects the significant changes in the individual’s intellectual environment” (p.78). When a significant change occurs within the individual’s environment the alpha level must change, which determines how the absolute intellectual level at maturity is affected. Zajonc and Markus

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1 The change in the label of the function is important only insofar as describing the number of siblings that the first-born has. The variable of interest in the equation is still “\( t \).” The alpha level also becomes important when the child of interest has additional siblings, which changes the intellectual environment of the child.
assume (based on the Belmont and Marolla study) that the intellectual environment gets diluted with more children, therefore a higher alpha level (more siblings, or more significant changes in the intellectual environment) causes children within a family to score lower on tests that involve any dimension of intellect.

Zajonc and Markus (1975) provide an example of the functionality of this equation by comparing the Raven scores for the only child \((M_1 = 100.0)\) and the firstborn of two \((M_2 = 100.57)\). Using the equation presented previously we can find the alpha level (demonstrates how profound the effect significant changes in the environment can have on the intellectual capabilities of an individual) of each group of individuals and determine what intellectual differences exist between only children, and the firstborn of two children. Zajonc and Markus assume \(k\) to have a value of .1, and the mean gap between the firstborn and second born to be two years, therefore the equation is as follows:

\[
\begin{align*}
M_{11} &= \alpha_0(1 - e^{-(.1)^2(19)^2}) = 100.00 \\
M_{12} &= \alpha_0(1 - e^{-(.1)^2(19)^2}) \\
&\quad + [\alpha_1(1 - e^{-(.1)^2(19)^2}) \\
&\quad - \alpha_1(1 - e^{-(.1)^2(19)^2})] = 100.57, \quad (3)
\end{align*}
\]

The variable that is being solved for is \(\alpha\). This equation assumes that a 19 year-old has reached their absolute intellectual ability, therefore “t” is given the value of 19 in the first part of the equation, which describes the absolute intellectual ability of only children. When solving for \(\alpha\) with regards to the firstborn of two children “t” will have a value of 19, reflecting the age of the individuals being tested. Because the mean gap between the firstborn and the second born is two years, “t” will have a value of two. The parameters of this model are able to predict not only intellectual levels of individuals at any given age, but it can also predict the effect that age gaps between subsequent children can have on intellectual development. Based on the equation, the larger the age gap, the more intellectually developed lower birth order individuals can become,
and if the gap is large enough, the individual can even surpass older siblings in intellectual ability.

Zajonc and Markus conclude that five features can be ascertained from the Belmont and Marolla data. First, intellectual performance decreases in lower birth order individuals, but with large spacing between the children the pattern can be reversed. Second, intellectual capacity decreases as family size increases because the intellectual environment cannot support the number of children. Third, the last child does not get to “teach” any of his or her siblings, which causes the last child to have the largest drop in intelligence scores. Fourth, only children suffer the same handicap that the last child has because an only child does not get to teach anyone. Fifth, the largest families had an escalation in intelligence scores for the later children because their intellectual abilities were very similar.

In conclusion, Zajonc and Markus focused primarily on the intellectual environment in the creation of the confluence model. Two dominant attributes of the intellectual environment can be ascertained from the research. First, the overall intellectual level of the environment plays a major role in the intellectual development of the individual. Second, the presence of younger siblings to teach assists individuals in positive intellectual development. Therefore, Zajonc and Markus describe the ideal situation for maximum intellectual development as being the firstborn in a family of two, with the birth of the younger sibling falling directly after the birth of the first child. The firstborn would then be required to have a teaching role very early in development, and the intellectual environment would not be too crowded.

Critiquing the Confluence Model

One critique of the confluence model as developed based on aggregate data from the Belmont and Carolla (1973) study is that the researchers failed to account for socioeconomic
status in their data. It is likely that less intellectual individuals will have more children based on the necessity of continuing work in outlying communities (ie. farming communities), and individuals with higher intellectual abilities will have less children, because it isn’t necessary to have more children to assist the family in its survival. If socioeconomic status is an important factor, then birth order may have a large impact on intellectual development, and the confluence model does not have legitimacy with regards to the correlation between birth order and intellectual development.

In 1984, Joseph L. Rodgers tested the confluence model using data from the Fels Research Institute that had been collecting longitudinal psychological and physiological data since 1929. Rodgers did his research in an attempt to demonstrate the confluence model’s inability to accurately predict an individual’s intellectual development. The main focus in his critique of the confluence model is within-family development, and how it is not incorporated sufficiently into the confluence model. Rodgers contends that because Zajonc and Markus used aggregate data to generate the confluence model it is possible that other processes (not birth order effects) were the cause of the results that were attained. In addition, Rodgers argues that Zajonc and Markus described individual processes in the confluence model, therefore aggregate data is inappropriate to demonstrate the effect that birth order has on intellectual development. To substantiate his claims, Rodgers cites Berbaum and Moreland (1980) who assert, “the results obtained with aggregate data… leave open the possibility that the confluence model is inaccurate in describing the intellectual development of individuals” (p.507).

The Fels Research Institute measured children at six month intervals from birth until age 18, and the data included a total of 311 families (906 children), with adequate information about each child and their siblings, the family size for each family, and the birth orders and birthdates
of each child. Because of the completeness of the information about each subject, Rodgers was able to examine within-family characteristics that previous research had not been able to analyze. Rodgers analyzed this data against the confluence model and simple linear models. Rodgers (1984) discovered that simple linear models were more effective in predicting intellectual ability in the Fels data than the confluence model. Rodgers concluded that the confluence model is unnecessarily complex, and a simple linear model is preferable. Rodgers restates the misgivings he has about the confluence model in 1988 where he argues, “Whether a child’s birth order is related to intellectual development is a much more important question than whether the confluence model gets due credit for predicting aggregate relationships” (p.477).

In conclusion, the mathematical complexity of the confluence model gives many researchers reservations about undertaking the task of correlating birth order and intellectual development. The sheer number of variables that go into an analysis of birth order effects as predicted by the confluence model, combined with the cost of said analysis has prompted researchers to search for alternative methods of correlating birth order and intellectual development. Despite the confluence model’s ability to predict intellectual ability using aggregate data, it is unable to account for individual differences within the population (especially within families), which precipitates doubt about its real world applications.
Bibliography


Schooler, C. *Birth Order effects: Not here, not now!* Psychological Bulletin, 1972, 78, 161-175.

