# C

## Confluence Model

John F. Kihlstrom
University of California, Berkeley,
Berkeley, CA, USA

The confluence model is a general framework for understanding developmental processes by tracing the mutual influences between the individual and his or her social environment as they unfold over time to shape some characteristic of personality. The term employs a riparian metaphor, referring to the merging of two watercourses, such as the Allegheny and the Monongahela Rivers at Pittsburgh. The essential feature of the confluence model is that "the individual is considered to be a part of his own environment" (Zajonc and Markus 1975, p. 86).

### A Birth Order Effect on Intelligence

The confluence model was initially proposed by Zajonc and Markus (1975) as an explanation for a striking pattern in the relationship between birth order, family size (i.e., number of siblings), and intellectual performance observed in a study by Belmont and Marolla (1973). As part of routine testing for the military draft, the Dutch government had administered Raven's Progressive Matrices, a culture-fair, nonverbal intelligence test, to every Dutch male who reached age 19 in the years 1963–1966 ($N = 386{,}114$). When mean test scores were plotted as a function of both family size and birth order, five features stood out: (1) a *Family Size Effect*: average scores declined with family size; (2) a *Birth-Order Effect*: within each family size, average scores declined with birth order; (3) the rate of decline diminished with later birth ranks; (4) a *Last-Child Effect*: last-born children showed a greater decline in average score than any other birth rank; and (5) only children had a lower average scores than the firstborns of a two-child family. The overall effects were small, with the large sample size obviously contributing to statistical significance: the distance between the highest and lowest point on the graph was less than two points. But in psychology as in physics, big theories can be built on small effects.

### The Confluence Model of Intellectual Development

In order to explain the joint effects of family size and birth order on intellectual performance, Zajonc and Markus (1975) proposed a *confluence model of intellectual development*. This model traces the mutual intellectual influences among children, and their parents, as the former develop. The major features of the model are as follows: The *Dilution Effect:* A newborn child effectively diminishes the intellectual resources available within a family. Newborns literally do not know


V. Zeigler-Hill, T. K. Shackelford (eds.), *Encyclopedia of Personality and Individual Differences*,
https://doi.org/10.1007/978-3-319-28099-8_1617-1

very much, and their lack of declarative and procedural knowledge, as well as their inability to interact linguistically with other family members, drags the whole family down. The *Growth Effect:* Each child contributes more intellectual resources to the family as he or she grows up. Over time, this growth brings the family average back up toward baseline. But if more siblings come into the family, each new child is born into a progressively diminished intellectual environment. This is an extension of the dilution effect. At the same time, each child in the family is growing up, and the intellectual growth of early-born siblings progressively enhances the intellectual environment for the whole family. To some extent, this extension of the growth effect created by earlyborns counteracts the dilution effect created by the latterborns.

There is also a *Teaching Effect*: Earlyborns profit from the presence of latterborns, because they get intellectual stimulation from teaching younger siblings. On the negative side, there is the *Last-Child Handicap:* Last-born children do not get the benefit of the teaching effect, simply because there are no younger siblings for them to teach. Therefore, they are at a special disadvantage. In addition, there is the *Only-Child Handicap:* For the same reason, an only child does not get the benefit of the teaching effect. This puts only children at a disadvantage compared even to the firstborns of small families. In a sense, the only child is both a firstborn and a last-born.

The confluence model makes the interesting prediction that twins and triplets should be even more disadvantaged than only children, because their simultaneous birth produces a stronger dilution effect. This was, in fact, the case in the Belmont-Marolla data, but of course the precise outcome depends on details of any other siblings: birth order, spacing, and the like. The confluence theory also has some other implications. Children from single-parent households may be at a special disadvantage, because there is a stronger dilution effect with only one parent in a household. Of course, there may be other adults present, such as grandparents or paramours, who can substitute for the missing parent. Children from extended families may be at a special advantage, because there are many of adults (aunts and uncles and older cousins) around to counteract the dilution effect.

In the confluence model, "intellectual performance" can be assessed by a wide variety of cognitive tests, including conventional intelligence tests, but it should not be confused with IQ. IQ scores are standardized with respect to age so that, at least in principle, an individual's measured intelligence remains constant across time. But in the confluence model, intellectual level grows with experience and so is better represented by something like mental age, uncorrected by chronological age. The Belmont-Marolla study reported mean IQ scores, standardized around a mean of 100, but because the subjects were all the same age, IQ was essentially a measure of mental age. Mental age is obviously correlated with chronological age, but the distinction is conceptually important. In the confluence model, the terms "intelligence" or "intellectual performance" do not refer to IQ, but to "absolute intellectual level" (p. 76) overall level of cognitive development, which almost by definition increases over time, eventually reaching a plateau.

## Controversies and Clarifications

The confluence model is inspired by birth-order effects, which have long been controversial (Schooler 1972). In the birth-order literature, for example, it is important to distinguish between "between-family" and "within-family" designs. In between-family designs, the subjects are unrelated to each other. In the Belmont-Marolla data, for example, all the subjects were 19 years old, so one subject might be a first-born from one family while another might be a latter-born from a different family. Between-family data is easier to collect, but between-family designs are typically unable to control for between-family differences such as family size (a fifth-born child necessarily has at least four other siblings), parental age at birth, socioeconomic status (generally, low-SES families are larger than high-SES families), and other variables that might be correlated with intelligence. In within-family studies, all these factors are controlled for, except that birth order is confounded with age: first-borns must, necessarily, be older than latter-borns. There is no perfect study. Birth-order effects often disappear in within-family analyses, but not always. A large national sample from Norway found a significant birth-order effect on intelligence regardless of whether the data was analyzed between or within families (Bjerkedal et al. 2007).

The confluence model is not just a verbal theory, of the sort usually found in social psychology. A mathematical representation of the confluence model, taking into account only birth order, family size, and the last-child handicap (i.e., the absence of the teaching function), the original version of the model accounted for fully 97% of the variance in the Belmont-Marolla data (Zajonc and Markus 1975).

The actual effects of dilution and growth depend on the spacing of childbirths. If siblings are spaced closely together, the dilution effect is increased. If siblings are spaced farther apart, the dilution effect is weakened. In large families, some earlyborns are much older than some latterborns. Therefore, the dilution effect is weakened for these latterborn children – unless the earlyborns are so much older that they have left the household. A revised version, altering the mathematical form of the confluence model and adding a parameter representing the spacing of children within a family (estimated from national data), provided an excellent fit to the aggregate data of both the original Belmont-Marolla data ($r = 0.94$; Zajonc 1976) and a Scottish dataset that found the usual negative effect of family size on IQ, but no birth-order effect ($r = 0.86$; Markus and Zajonc 1977).

Because the confluence model is concerned with mental age, the age at which subjects are tested is critical. The teaching effect counteracts the dilution effect, but they are not equally strong and change at different rates. As a result, the negative birth order effect tends not to appear until the early to middle teens –hence the striking pattern observed in 19-year-olds by Belmont and Marolla. A third "reparameterized" model (Zajonc et al. 1979) added the age at which the individual was tested, and gave a good account of the aggregate data from six national datasets, including the Dutch and Scottish data – not all of which actually showed a negative birth-order effect (average $r = 0.96$; see also Zajonc 1983; Zajonc and Bargh 1980).

One interesting outcome of these and other modeling exercises is the discovery that the effect of birth order per se is far less important than the spacing of children within the family. Depending on this and other factors, such as family size, the effects of birth order can be negative (as in the Belmont-Marolla study), null (as found in some other studies), positive, or even U-shaped. This fact, the confluence model is not really about either birth order or family size. Rather, it is about the entire family environment, the developing child's changing contributions to it, and the legacy of changes in family structure for the individual. Birth order, family size, spacing, and other demographic variables are just proxies for these other psychosocial variables.

The confluence model poses a kind of paradox, in that Zajonc and his colleagues employed aggregate data (i.e., mean test scores of different birth ranks in different-sized families) to test hypotheses about individual differences. When the confluence model is applied to within-family data, it accounts for less variance in intelligence than when applied to between-family data (Berbaum and Moreland 1980). This is because there are other factors, not the least of which are genetic in nature, that also account for individual differences in intelligence but are not accounted for in the confluence model.

Nor does the confluence model encompass all possible intrafamilial influences on intelligence, such as actual level of parental intelligence, which moderates the dilution effect. For example, in a study by Galbraith (1982), the confluence model fared poorly when applied to a large sample of Brigham Young University students, most of whom are members of the Church of Jesus Christ of Latter-Day Saints. Certain aspects of Mormon culture, such as the value given to large, extended families, and extensive parental involvement with children, may well mitigate the consequences of family size and birth order, such as the dilution effect and the last-child handicap.

In addition to controversy over the empirical status of birth-order effects, the confluence model has been subject to various technical criticisms. For example, Galbraith (1982, 1983) argued that the confluence model was internally inconsistent (see also Barbut 1993; Retherford and Sewell 1991). Price and his colleagues (1984) asserted that the success of the model was an artifact of the correlation between mental and chronological age. Along similar lines, Rodgers (1984) and McCall (1985) complained that the confluence model failed the test of parsimony, in that much simpler models accounted for the data almost as well. Zajonc and his colleagues countered that most of the technical criticisms reflected misunderstandings or misapplications of the confluence model, and reasserted that the model does an excellent job at what it was intended for: explaining the aggregate effects of birth order and family size on intellectual development (Berbaum et al. 1982, 1986; Zajonc 1983, 1993; Zajonc et al. 1991). In addition, the confluence model predicted *in advance* the decline of average SAT scores which occurred between 1960 and 1983, and their subsequent rise through 1985, based on changes in average family size (Zajonc 1976, 1986).

Perhaps the most substantive challenge to the confluence model is that it offers a within-family explanation of the effects family configuration on intelligence when the correct explanation involves between-family differences (Rodgers 1984, 2001a, b; Rodgers et al. 2000; Wichman et al. 2007). The confluence model holds, essentially, that large families create an intellectual disadvantage for the children who are born into them. Rodgers and his colleagues reverse the direction of causality: it is not that "large families make low-IQ children," but rather that "low-IQ parents make large families" (Rodgers et al. 2000, p. 610). Put more gently, birth order effects are an artifact of family size, and family size is "a proxy for between-family variables like SES, educational level, nutritional quality, maternal age, and so forth" (p. 611) that are correlated with intelligence. They supported their argument with an analysis of within-family data, but Zajonc (2001) pointed out that such an analysis necessarily confounds birth order with age (see also Zajonc and Mullally 1997; Zajonc and Sulloway 2007). Both aggregate and individual-level analyses have their purposes and virtues, but between-family data can reveal trends that within-family data can obscure.

Although inspired by findings relating birth order and family size to intelligence, ability, the confluence model is not limited to these matters. For example, Zajonc and Markus (1975) themselves suggested confluence models of other personality characteristics. First-born children may be more dependent on their parents, thus preempting access to the parents by latterborns, and forcing them to become more independent. Affiliation on the other hand, may increase for latterborns, because the greater availability of affiliative targets may foster the development of affiliative skills. On the other hand, if earlyborns serve as teachers for latterborns, they may develop stronger leadership skills. Similarly, Dishion and his colleagues proposed a confluence model of antisocial behavior in children in which early instances of aggression lead to rejection by the child's peer group, which leads the child to turn to other antisocial children for friendships, which will reinforce the child's own aggressive predispositions (Dishion et al. 1994).

## Confluence Models in Other Domains

"Confluence" models have been proposed in various other domains. Eviatar et al. (1994) proposed a "confluence model" of in which both physical and nominal dimensions play a role in similarity judgments, regardless of which dimension is specified by the comparison task. Malamuth et al. (1995) proposed a "confluence model" of sexual aggression involving the combined effects of two personality characteristics: hostile masculinity and an orientation toward promiscuous–impersonal sex. However, neither of these models possesses the critical feature of Zajonc's confluence model, which is that the individual is part of his or her own environment, and the environment is partly of his or her own making.

## Confluence and Interactionism

The confluence model may be seen as a variant on the Doctrine of Interactionism in personality theory, which states that "*situations are as much a function of the person as the person's behavior is a function of the situation*" (Bowers 1973, p. 327, italics original; see also Kihlstrom 2013). As Zajonc and Markus put it (p. 86, italics original):

> The main feature of the formulation is that *the individual is considered to be a part of his own environment.* And this environment is conceived of not as a static and stable background condition, but as one that changes over time, and one that is dynamically interdependent with its components. The individual is continually influenced by his own environment, and being thus influenced and changed, himself brings about changes in his environment *by virtue of his very own change.*

In this instance, newborns initially dilute the intellectual environment of their families, but make increasingly positive contributions to it as they mature, interact with other family members (as these move into and out of the family), take on the teaching function, etc.

Interactionism, in turn, exemplifies Lewin's (1939/1951) "Grand Truism" (Jones 1985), $B = f(P,E)$: that the person and the situation constitute a single interdependent dynamic "field"; and the Gestalt Principle that the whole is not the same as the sum of its parts. At Pittsburgh, the Allegheny and the Monongahela become the Ohio – an entirely different river.

## References


Barbut, M. (1993). Comments on a pseudo-mathematical model in social psychology. *European Journal of Social Psychology, 23*(2), 203–210. https://doi.org/10.1002/ejsp.2420230208.

Belmont, L., & Marolla, F. A. (1973). Birth order, family size, and intelligence. *Science, 182*, 1096–1101. https://doi.org/10.1126/science.182.4117.1096.

Berbaum, M. L., & Moreland, R. (1980). Intellectual development within the family: A new application of the confluence model. *Developmental Psychology, 16*(5), 506–515. https://doi.org/10.1037/0012-1649.16.5.506.

Berbaum, M. L., Markus, G. B., & Zajonc, R. B. (1982). A closer look at Galbraith's "closer look". *Developmental Psychology, 18*(2), 174–180. https://doi.org/10.1037/0012-1649.18.2.174.

Berbaum, M. L., Moreland, R. L., & Zajonc, R. B. (1986). Contentions over the confluence model: A reply to Price, Walsh, and Vilburg. *Psychological Bulletin, 100*(2), 270–274. https://doi.org/10.1037/0033-2909.100.2.270.

Bjerkedal, T., Kristensen, P., Skjeret, G. A., & Brevik, J. I. (2007). Intelligence test scores and birth order among young Norwegian men (conscripts) analyzed within and between families. *Intelligence, 35*(5), 503–514. https://doi.org/10.1016/j.intell.2007.01.004.

Bowers, K. S. (1973). Situationism in psychology – Analysis and a critique. *Psychological Review, 80*, 307–336. https://doi.org/10.1037/h0035592.

Dishion, T. J., Patterson, G. R., & Griesler, P. C. (1994). Peer adaptations in the development of antisocial behavior: A confluence model. In L. R. Huesmann (Ed.), *Aggressive behavior: Current perspectives* (pp. 61–95). New York: Plenum.

Eviatar, Z., Zaidel, E., & Wickens, T. (1994). Nominal and physical decision criteria in same-different judgments. *Perception & Psychophysics, 56*(1), 62–72. https://doi.org/10.3758/BF03211691.

Galbraith, R. C. (1982). Sibling spacing and intellectual development: A closer look at the confluence models. *Developmental Psychology, 18*(2), 151–173. https://doi.org/10.1037/0012-1649.18.2.151.

Galbraith, R. C. (1983). Individual differences in intelligence: A reappraisal of the confluence model. *Intelligence, 7*(2), 185–194. https://doi.org/10.1016/0160-2896(83)90028-4.

Jones, E. E. (1985). Major developments in social psychology since 1930. In G. Lindzey & E. Aronson (Eds.), *Handbook of social psychology* (Vol. 1, 2nd ed., pp. 47–107). Reading: Addison-Wesley.

Kihlstrom, J. F. (2013). The person-situation interaction. In D. Carlston (Ed.), *Oxford handbook of social cognition* (pp. 786–805). New York: Oxford University Press.

Lewin, K. (1939/1951). Field theory and experiment in social psychology: Concepts and methods. In K. Lewin (Ed.), *Field theory in social science* (pp. 130–154). New York: Harper & Row. (Reprinted from: 1951).

Malamuth, N. M., Linz, D., Heavey, C. L., Barnes, G., & Acker, M. (1995). Using the confluence model of sexual aggression to predict men's conflict with women: A 10-year follow-up study. *Journal of Personality and Social Psychology, 69*(2), 353–369. https://doi.org/10.1037/0022-3514.69.2.353.

Markus, G. B., & Zajonc, R. B. (1977). Family configuration and intellectual development: A simulation. *Behavioral Science, 22*(2), 137–142. https://doi.org/10.1002/bs.3830220208.

McCall, R. B. (1985). The confluence model and theory. *Child Development, 56*(1), 217–218. https://doi.org/10.2307/1130187.

Price, G. G., Walsh, D. J., & Vilberg, W. R. (1984). The confluence model's good predictions of mental age beg the question. *Psychological Bulletin, 96*(1), 195–200. https://doi.org/10.1037/0033-2909.96.1.195.

Retherford, R. D., & Sewell, W. H. (1991). Birth order and intelligence: Further tests of the confluence model. *American Sociological Review, 56*(2), 141–158. https://doi.org/10.2307/2095775.

Rodgers, J. L. (1984). Confluence effects: Not here, not now. *Developmental Psychology, 20*(2), 321–331. https://doi.org/10.1037/0012-1649.20.2.321.

Rodgers, J. L. (2001a). The confluence model: An academic "tragedy of the commons?". In E. L. Grigorenko & R. J. Sternberg (Eds.), *Family environment and intellectual functioning: A life-span perspective* (pp. 71–95). Mahwah: Erlbaum.

Rodgers, J. L. (2001b). What causes birth order-intelligence patterns? The admixture hypothesis, revived. *American Psychologist, 56*(6–7), 505–510. https://doi.org/10.1037/0003-066X.56.6-7.505.

Rodgers, J. L., Cleveland, H. H., van den Oord, E., & Rowe, D. C. (2000). Resolving the debate over birth order, family size, and intelligence. *American Psychologist, 55*(6), 599–612. https://doi.org/10.1037/0003-066X.55.6.599.

Schooler, C. (1972). Birth order effects: Not here, not now! *Psychological Bulletin, 78*, 161–175. https://doi.org/10.1037/h0033026.

Wichman, A. L., Rodgers, J. L., & MacCallum, R. C. (2007). Birth order has no effect on intelligence: A reply and extension of previous findings. *Personality and Social Psychology Bulletin, 33*(9), 1195–1200. https://doi.org/10.1177/0146167205279581.

Zajonc, R. B. (1976). Family configuration and intelligence: Variations in scholastic aptitude scores parallel trends in family size and the spacing of children. *Science, 192*, 227–236. https://doi.org/10.1126/science.192.4236.227.

Zajonc, R. B. (1983). Validating the confluence model. *Psychological Bulletin, 93*(3), 457–480. https://doi.org/10.1037/0033-2909.93.3.457.

Zajonc, R. B. (1986). The decline and rise of scholastic aptitude scores: A prediction derived from the confluence model. *American Psychologist, 41*(8), 862–867. https://doi.org/10.1037/0003-066X.41.8.862.

Zajonc, R. B. (1993). The confluence model: Differential or difference equation. *European Journal of Social Psychology, 23*(2), 211–215. https://doi.org/10.1002/ejsp.2420230209.

Zajonc, R. B. (2001). The family dynamics of intellectual development. *American Psychologist, 56* (6–7), 490–496. https://doi.org/10.1037/0003-066X.56.6-7.490.

Zajonc, R. B., & Bargh, J. (1980). The confluence model: Parameter estimation for six divergent data sets on family factors and intelligence. *Intelligence, 4*(4), 349–361. https://doi.org/10.1016/0160-2896(80)90028-8.

Zajonc, R. B., & Markus, G. B. (1975). Birth order and intellectual development. *Psychological Review, 82*, 74–88. https://doi.org/10.1037/h0076229.

Zajonc, R. B., & Mullally, P. R. (1997). Birth order: Reconciling conflicting effects. *American Psychologist, 52*(7), 685–699. https://doi.org/10.1037/0003-066X.52.7.685.

Zajonc, R. B., & Sulloway, F. J. (2007). The confluence model: Birth order as a within-family or between-family dynamic? *Personality and Social Psychology Bulletin, 33*(9), 1187–1194. https://doi.org/10.1177/0146167207303017.

Zajonc, R. B., Markus, H., & Markus, G. B. (1979). The birth order puzzle. *Journal of Personality and Social Psychology, 37*(8), 1325–1341. https://doi.org/10.1037/0022-3514.37.8.1325.

Zajonc, R. B., Markus, G. B., Berbaum, M. L., Bargh, J. A., & Moreland, R. L. (1991). One justified criticism plus three flawed analyses equals two unwarranted conclusions: A reply to Retherford and Sewell. *American Sociological Review, 56*(2), 159–165. https://doi.org/10.2307/2095776.